TRANSACTIONS
OF THE
AMERICAN FISHERIES SOCIETY

FIFTY-SIXTH ANNUAL MEETING

MOBILE, ALABAMA

SEPTEMBER 22, 23, 24, 1926

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Published Annually by the Society

HARTFORD, CONNECTICUT

1926

American Fisheries Society

ORGANIZED 1870 INCORPORATED 1910

Officers for 1926-1927

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C. P. PETERSON.....Bisbee, N. D.

PRESIDENTS' TERMS OF SERVICE AND PLACES OF MEETING

The first meeting of the Society occurred December 20, 1870. The organization then effected continued until February, 1872, when the second meeting was held. Since that time there has been a meeting each year, as shown below. The respective presidents were elected at the meeting, at the place, and for a period shown opposite their names, but they presided at the subsequent meeting.

1.	William Clift	1870-1872	New York, N. Y.
2.	William Clift	1872-1873	Albany, N. Y.
3.	William Clift	1873-1874	New York, N. Y.
4.	Robert B. Roosevelt	1874-1875	New York, N. Y.
5.	Robert B. Roosevelt	1875-1876	New York, N. Y.
6.	Robert B. Roosevelt	1876-1877*	New York, N. Y.
7.	Robert B. Roosevelt	1877-1878	New York, N. Y.
8.	Robert B. Roosevelt	1878-1879	New York, N. Y.
9.	Robert B. Roosevelt	1879-1880	New York, N. Y.
10.	Robert B. Roosevelt	1880-1881	New York, N. Y.
11.	Robert B. Roosevelt	1881-1882	New York, N. Y.
12.	George Shepard Page	1882-1883	New York, N. Y.
13.	James Benkard	1883-1884	New York, N. Y.
14.	Theodore Lyman	1884-1885	Washington, D. C.
15.	Marshall McDonald	1885-1886	Washington, D. C.
16.	W. M. Hudson	1886-1887	Chicago, Ill.
17.	William L. May	1887-1888	Washington, D. C.
18.	John Bissell	1888-1889	Detroit, Mich.
19.	Eugene G. Blackford	1889-1890	Philadelphia, Pa.
20.	Eugene G. Blackford	1890-1891	Put-in Bay, Ohio.
21.	James A. Henshall	1891-1892	Washington, D. C.
22.	Herschel Whitaker	1892-1893	New York, N. Y.
23.	Henry C. Ford	1893-1894	Chicago, Ill.
24.	William L. May	1894-1895	Philadelphia, Pa.
25.	L. D. Huntington	1895-1896	New York, N. Y.
26.	Herschel Whitaker	1896-1897	New York, N. Y.
27.	William L. May	1897-1898	Detroit, Mich.
28.	George F. Peabody	1898-1899	Omaha, Nebr.
29.	John W. Titcomb	1899-1900	Niagara Falls, N. Y.
30.	F. B. Dickerson	1900-1901	Woods Hole, Mass.
31.	E. E. Bryant	1901-1902	Milwaukee, Wis.
32.	George M. Bowers	1902-1903	Put-in Bay, Ohio.
33.	Frank N. Clark	1903-1904	Woods Hole, Mass.
34.	Henry T. Root	1904-1905	Atlantic City, N. J.
35.	C. D. Joslyn	1905-1906	White Sulphur Springs, W. Va.
36.	E. A. Birge	1906-1907	Grand Rapids, Mich.
37.	Hugh M. Smith	1907-1908	Erie, Pa.
38.	Tarleton H. Bean	1908-1909	Washington, D. C.
39.	Seymour Bower	1909-1910	Toledo, Ohio
40.	William E. Meehan	1910-1911	New York, N. Y.
41.	S. F. Fullerton	1911-1912	St. Louis, Mo.
42.	Charles H. Townsend	1912-1913	Denver, Colo.
43.	Henry B. Ward	1913-1914	Boston, Mass.
44.	Daniel B. Fearing	1914-1915	Washington, D. C.
45.	Jacob Reighard	1915-1916	San Francisco, Calif.
46.	George W. Field	1916-1917	New Orleans. La.
47.	Henry O'Malley	1917-1918	St. Paul, Minn.
48.	M. L. Alexander	1918-1919	New York, N. Y.

49.	Carlos Avery	1919-1920	Louisville, Ky.
50.	Nathan R. Buller	1920-1921	Ottawa, Canada.
51.	William E. Barber	1921-1922	Allentown, Pa.
52.	Glen C. Leach	1922-1923	Madison, Wis.
53.	George C. Embody	1923-1924	St Louis, Mo.
54.	Eben W. Cobb	1924-1925	Quebec, Canada.
55.	Charles O. Hayford	1925-1926	Denver, Colo.
56.	John W. Titcomb	1926-1927	Mobile, Alabama.

*A special meeting was held at the Centennial Grounds, Philadelphia, Pa., October 6 and 7, 1876.

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PART I

BUSINESS SESSIONS

PROCEEDINGS

of the

American Fisheries Society

FIFTY-SIXTH ANNUAL MEETING

at

MOBILE, ALABAMA

September 22, 23, 24, 1926

The Fifty-sixth Annual Meeting of the American Fisheries Society convened at The Battle House, Mobile, Ala., on Wednesday, September 22, 1926, at 10 a. m., President Charles O. Hayford in the Chair.

REGISTERED ATTENDANCE

J. F. DAVIS, District Game Warden, Monroeville, Ala.
J. C. FORSYTH, Supt. State Hatchery, Forest Hill, La.
LEE MILES, Chairman, Arkansas Game and Fish Commission, Little Rock.
GEORGE BERG, Superintendent State Hatcheries, Indiana.
D. E. PETTIS, State Game Warden, Phoenix, Ariz.
C. J. MEREDITH, Superintendent Wardens, Kentucky Game and Fish Commission, Frankfort, Ky.
A. R. REEVES, State Game Warden, Oklahoma City, Okla.
GEO. N. MANNFELD, Superintendent Fisheries and Game, Department of Conservation, Indianapolis, Ind.
T. SURBER, Superintendent Fish Propagation, Game and Fish Department, St. Paul, Minn.
W. P. MANN, Game Warden, Alex City, Ala.
J. O. COX, Game Warden, Speigner, Ala.
C. G. HIXON, Game Warden, Union Springs, Ala.
KEITH MCCANSE, Game and Fish Commissioner, Jefferson City, Mo.
H. D. PALLISTER, Director, State Mine Experiment Station, Mobile, Ala.
E. S. SUMERFORD, Game and Fish Warden, Abbeville, Ala.
W. B. MORTON, Game Warden, Thomaston, Ala.
J. T. DUMAS, Chatom, Ala.
TED COTTRELL, Chief Game Warden, Birmingham, Ala.
C. C. REEVES, Visitor, Birmingham, Ala.
O. C. SONSOM, District Game Warden, Gadsden, Ala.
JAS. WATSON, District Game Warden, Opp, Ala.

A. R. LIGHTSEY, District Game Warden, Centreville, Ala.
J. L. MCCOLLUM, District Game Warden, Selma, Ala.
HENRY BUFORD, Superintendent State Fish Hatchery, Eastaboga, Ala.
C. P. PETERSON, Game and Fish Commission, Bisbee, N. D.
C. F. CULLER, U. S. Bureau of Fisheries, La Crosse, Wis.
M. D. HART, Department Game and Inland Fisheries, Richmond, Va.
CHAS. R. POLLOCK, State Supervisor Fisheries, Seattle, Wash.
J. W. TITCOMB, Connecticut State Board of Fisheries and Game, Hartford.
PERCY VIOSCA, JR., Biologist, Louisiana Department of Conservation, New Orleans, La.
CHAS. O. HAYFORD, Superintendent Fish Culture, Hackettstown, N. J.
CARLOS AVERY, Secretary, New York.
E. C. YOUNG, Ottawa, Canada.
JAMES A. LAIRD, Superintendent Fisheries, South Side Sportsmen's Club, Oakdale, N. Y.
GUY AMSLER, Secretary, Arkansas Game and Fish Commission, Little Rock, Ark.
E. P. DAUGHDRILL, Game Warden, Oneonta, Ala.
JOHN M. DANIEL, Game Warden, Round Mountain, Ala.
E. A. TULIAN, Director, Fisheries Division, New Orleans, La.
GEO. C. WAGGONER, Executive Agent, Game and Fish Commission, Frankfort, Ky.
E. LEE LECOMPTE, State Game Warden, Baltimore, Md.
A. W. DANIELS, Game Warden, Chocolacco, Ala.
A. R. BRITTON, Game Warden, Hamilton, Ala.
I. E. ADAMS, Game Warden, Greenville, Ala.
A. Z. OBERHAUS, District Game Warden, Mobile, Ala.
E. B. MOODY, District Game Warden, Montgomery, Ala.
W. E. ALBERT, Warden, Fish and Game Department, Des Moines, Iowa.
J. B. DOZE, Warden, Fish and Game Department, Pratt, Kansas.
F. C. WALCOTT, President, Connecticut State Board of Fisheries and Game, Norfolk, Conn.
I. T. QUINN, Commissioner, Game and Fisheries, Montgomery, Ala.
C. M. HARWELL, District Warden, Huntsville, Ala.
F. J. FOSTER, Chief of Hatcheries of Missouri, Jefferson City, Mo.
W. A. KING, (Snake King), Brownsville, Texas.
SAM H. LACKLAND, Mobile, Ala.
MRS. CARLOS AVERY, New York.
ROBERT A. HAYFORD, State Hatchery, Hackettstown, N. J.
EMMELINE MOORE, Investigator in Fish Culture, Albany, N. Y.
G. C. LEACH, Division of Fish Culture, Washington, D. C.

FIRST SESSION.

Wednesday Morning, September 22.

PRESIDENT HAYFORD: Will the Fifty-sixth Annual Meeting of the American Fisheries Society please come to order? I will ask Mr. Quinn to introduce the Hon. John McDuffie, Congressman for the First District of Alabama.

MR. I. T. QUINN (Alabama): Mr. President and Members of the American Fisheries Society: In the first place I want to extend to each and all of you the most cordial welcome. We are not going to present you with a display of the elements as we did the International Association, because a number of you who went through the experience do not want it repeated.

I shall not take up your time by telling you about the facilities that are ordinarily available here for fishing—how you can get almost any kind of salt water or fresh water fish swimming side by side for miles up and down Mobile River and even out into the Bay; how we have every fish known to this latitude, the gamest fish the world has ever produced—the tarpon. We had intended to take you gentlemen today to the place where you could get the biggest, the best and the fightingest tarpon that swims the seas, right here in Mobile Bay. But the events that have just passed forbid our going to Fort Gaines or Fort Morgan, thirty-five miles away.

(Mr. Quinn then proceeded to introduce Mr. McDuffie, who delivered an address of welcome.)

MR. MCDUFFIE said in part:

Your program in Washington is one designed to bring about great good to the nation as a whole. The fishing industry is a very large industry in this country, aside from the sportsmanship of it. I have never seen a man who loved the reel and rod, and was a true sportsman, who did not have a lot of good in him. Generally you find him a great, big-hearted, whole-souled, splendid American citizen, and that is the type of man who is especially interested in your work from the standpoint of sportsmanship and pleasure. But aside from that there is the great underlying principle in which you gentlemen are most of all interested, and that is the question of food supply and of having a sufficiency of all our natural resources in the event of need; and we cannot have them when we need them unless we start in time to preserve them. Now, we who are members of legislative bodies expect you gentle-

men to give us the information we desire and need in trying to help you work out your programs.

I do not suppose there is a greater section in United States for the propagation of fish than in this immediate vicinity. I wish you gentlemen might see these streams—how clear and beautiful and crystal-like they are; and having in mind the types of fish that may be propagated in these waters I have been anxious that the Federal Government should establish additional hatcheries throughout the country. The hatcheries at Tupelo and Warm Springs are the nearest ones for this immediate vicinity, and there are on file thousands of applications that sometimes have to wait their turn anywhere from twelve months to two years in Washington. Now, there is no need for a man to have to wait two years to get a few fish from Washington. There are certain services we have started, and among them is the Bureau of Fisheries of the Department of Commerce. I hope you gentlemen everywhere throughout the country will take up with your representatives in Washington the absolute necessity of expanding and enlarging the activity of that department. There is great need for this work, because the fish are necessary to the happiness as well as to the sustenance of our people, and I think no money has been better expended by the Federal Government than that which they appropriate every year for the Bureau of Fisheries.

So far as I can in my humble way I shall be glad to view with sympathy any suggestions you may have to offer in matters concerning the propagation and the conservation of the fish. I shall be happy to render such service as I can, because my heart is with you.

I repeat that you are heartily welcome to Mobile, and I wish you much success in your deliberations. We hope that when you come again we at least will have better weather conditions and be able to show you more of that hospitality which is characteristic of a splendid, fine old people.

PRESIDENT HAYFORD: I am sure you have all enjoyed, as I have, this most interesting address of Congressman McDuffie. We thank him very much indeed for his cordial welcome.

I wish to take this opportunity of thanking the Society for the splendid response and support that the Secretary and myself have received in our campaign for new members. It has enabled us to come to this meeting with the debt to the permanent fund cleaned up and with a small balance. I would further suggest that the membership campaign be continued. From the letters received I believe there are thousands of sportsmen in this country who would be glad to become mem-

bers of the American Fisheries Society if they were furnished with application blanks and advised what the Society has done and expects to do for the American angler.

Guy Amsler was elected treasurer pro tem.

New Members Elected.

The following were elected to membership in the Society:

United States Fisheries Association, 196 Water St., New York.
Chris Faulkner, Osceola, Wis.
John H. Ferris, Arlington, Vt.
William R. Robinson, Bennington, Vt.
Carl Lay, Gadsden, Ala.
Jean Borcea, Jassy, Rumania.
Henry J. Hury, Birmingham, Ala.
Conservation Department, State of Maryland.
W. T. Keller, 7338 Woodward, Detroit, Mich.
Henry Kissell, Jr., 241 Walker St., Cliffside, N. J.
George E. Philo, Constantia, N. Y.
F. Lawrence Bailliere, 220 W. 19th St., Tulsa, Okla.
John R. Greeley, 241 Linden Ave., Ithaca, N. Y.
Dr. E. L. Blackenship, Cassville, Mo.
Chas. R. Wiant, U. S. Fisheries Station, Tupelo, Miss.
Sam H. Lackland, 69 So. Ann St., Mobile, Ala.
Eugene W. Surber, 1539 Dayton Ave., St. Paul, Minn.
M. J. Hoye, State Fish Hatchery, St. Paul, Minn.
Patience Ellis Kidd, Department of Botany, University of Minnesota, Minneapolis, Minn.
Henry Schuil, 1320 Logan St., S. E., Grand Rapids, Mich.
Mashpee Trout Club, J. W. Farley, Secy., Federal St., Boston.
C. J. Meredith, Frankfort, Ky.
Ted Cottrell, Chief Game Warden, Birmingham, Ala.
Henry Buford, in charge of State Fish Hatchery, Eastabaga, Ala.
Dr. V. K. Irion, Commr. Dept. of Conservation, New Orleans, La.
L. P. Munger, Munger Realty Co., Birmingham, Ala.
M. Scholder, 1913 Second Ave., Birmingham, Ala.
B. F. Moore, Sr., *care* Moore-Handley Hardware Co., Birmingham, Ala.
Henry C. Hammond, Augusta, Ga.

The following members were added in the interim between the Denver and the present meeting:

G. M. Willard, Phoenix, Arizona.
Howard A. Fox, Harrisville, Mich.
Geo. A. Cuyler, State Fish Hatchery, Harrisville, Mich.
Wm. M. Hilliard, Harrisville, Mich.
Frank M. Corfman, Harrisville, Mich.

MAYNARD STICKNEY JOHNSON, University Farm, St. Paul, Minn.
WM. C. MOSS, Superintendent Crystal Spring Trout Hatchery, Port Allegany, Pa.
THOS. YOUNG, Pendleton, Oregon.
JOHN N. LOEW, Marquette, Mich.
JAMES M. MOTLEY, 19 West 54th Street, New York.
CHARLES R. POLLOCK, 414 Bell Street Terminal, Seattle, Wash.
SAMUEL I. BORGER, Brookhaven, N. Y.
A. H. LEIM, Biological Board of Canada, care University of Toronto, Toronto, Can.
J. H. CRUICKSHANK, 3120 Federal Street, El Paso, Texas.
SIDNEY SKILLMAN, Washington, N. J.
J. P. CUENIN, San Francisco Examiner, San Francisco, Calif.
FRANK MILLER, DeBruce, N. Y.
CHARLES T. TOMBLER, Mauch Chunk, Pa.
H. A. SOUTHARD, Grooville, N. Y.
ROBERT P. PECKETTS, Franconia, N. H.
J. F. HAMPTON, Linville, N. C.
F. A. SCOTT, 5701 Carnegie Avenue, Cleveland, Ohio.
E. L. WHITTEMORE, 12526 Cedar Road, Cleveland Heights, Ohio.
GEORGE W. CRILE, M. D., 2620 Derbyshire Road, Cleveland, Ohio.
J. B. ROYALL, Tallahassee, Fla.
IRVING L. TOWERS, Beaufort, N. C.
MIDDLESEX COUNTY HUNTING & FISHING CLUB, New Brunswick, N. J.
ADE EVERS, Nashville, Ark.
JAMES S. GUTSELL, Beaufort, N. C.
HENRY J. BOLLES, Bozeman, Mont.
P. G. BOTTLER, Emigrant, Mont.
JOSH COLLEY, Emigrant, Mont.
CARL H. MONSEES, Salisbury, Maryland.
K. MATSUNAGA, North Branch, N. J.
N. J. FISH & GAME COMMISSION, Trenton, N. J.
MOTT L. BARTLETT, Concord, New Hampshire.
LEE LARRABEE, Liberal, Kansas.
GEO. A. CLARK, Topeka, Kansas.
GILES ATHERTON, El Dorado, Kansas.
BEN S. PAULEN, Topeka, Kansas.
FREDERICK STRATTON RUSSELL, Citadel Hill, Plymouth, England.
JOHN G. KRUGER, Military Park Row, Newark, N. J.
HARRY L. HOBBS, Sayville, N. Y.
EDWARD E. ALLSOPP, Newark, N. J.
ALFRED DECOZEN, Newark, N. J.
T. H. LANGLOIS, Ann Arbor, Mich.
AUGUSTUS L. L. BAKER, Dover, N. J.
LEWIS SPINKS, Jersey City, N. J.

L. J. McLeod, Welaka, Florida.
J. C. Forsyth, Forest Hill, Louisiana.
Arthur W. Kade, Sheboygan, Wis.
Leonard Hunt, Bozeman, Mont.
R. S. W. Browne, Birmingham, Ala.
H. O. Bull, Plymouth, England.
Albert M. Powell, Lewistown, Md.
South Side Sportsmen's Club, Oakdale, L. I., N. Y.
Clinton J. Riley, Barberton, Ohio.
David H. Madsen, Salt Lake City, Utah.
Judson L. Wicks, Minneapolis, Minn.
C. H. Reynolds, Detroit, Mich.
Amy H. Marvin, New Preston. Conn.
Frank K. Smith, Clinton, Oklahoma.

REPORT OF THE SECRETARY

To the Officers and Members of the American Fisheries Society:—

The past year may fairly be said to have been a prosperous one in the affairs of the Society. The finances have been restored to a solvent condition and there has been an increase in active membership. During the past three years an indebtedness of $2,225.66 has been liquidated. Of this amount $855.92 was in outstanding bills and $1,369.74 was indebtedness to the permanent fund of the Society. The permanent fund is now intact and all bills are paid except a few incidentals such as postage and clerical services, which funds are now in hand to cover.

Your president has been exceptionally active in promoting a membership campaign which has produced excellent results and which should be continued actively by the incoming adminstration in order to realize its full benefit.

Funds to defray the expense of the membership campaign were collected by solicitation amounting to $173.00, contributed by seventeen members. Most of this still remains unexpended, but has been temporarily transferred by the treasurer to the general fund and used in liquidation of the indebtedness to the Permanent Fund. This membership fund was collected for a specific purpose and will, of course, eventually all be used for the purpose intended by the donors.

The treasurer has been diligent in keeping the members in good standing and in safeguarding the treasury. The librarian has made it possible to effect substantial savings in the expense of the transactions.

During the past year 83 new members, active and otherwise, have been added to the membership roll and 52 have been dropped for non-

payment of dues or have died or resigned, a net gain of 31 members, besides 19 applications in hand at this moment.

The total membership is now as follows:

Honorary members, including ex-officio members	64
Corresponding members	12
Patrons	53
Active members	462
Libraries	21
Clubs and dealers	33
State memberships	14
Life members	43
Total	702

Very little success has been realized from attempts to increase the list of club members. One new life member has been added. There should be more State memberships. The most promising field for recruiting new members is undoubtedly from libraries and interested individuals.

It is the duty of the secretary to solicit new members, but each member is in position to furnish effective assistance. If it is kept in mind and application blanks are kept handy it is surprising the new members that may be turned in. The secretary can do little without the names of prospects. For the purpose of supplying these nomination blanks are sent to members. Unfortunately few of these are used. Members are requested to make use of these whenever they receive them, or send names of prospective members any time, if they are not in position to solicit them personally.

A year's experience since the revision of the bylaws of the Society has suggested the advisability of other amendments.

In the matter of the distribution of the Transactions, those entitled to receive them should be definitely indicated. It is the practice to send them to paid up members and to life members only.

Members are now carried on the books in good standing to the next annual meeting after they join, and are then charged with another year's dues. Instead of running the membership from meeting to meeting it would seem more equitable to credit each new member for a year from the time he becomes a member, regardless of when it may be.

The secretary, and other officers as well, receive frequent requests for information as to papers which may have been published by the Society in its Transactions on various subjects. There is no way to furnish such information. There should be a printed catalogue, indexed as to subjects and authors of all publications of the Society, which might be sold for a nominal sum to pay the expense of compiling

and printing. The Society might well authorize the advancement of sufficient funds to cover such publication, to be restored from the proceeds of the sale of these catalogues. The reasons for this are obvious. There is a wealth of material in the archives of the Society which is now unavailable to students or others to whom it might be invaluable. It would stimulate the sale of Transactions.

The treasurer has heretofore recommended that authority should be given the officers of the Society to transfer members from the active list of life members in certain meritorious cases, rather than to permit them to be dropped for non-payment of dues, or to resign because unable to pay dues. This should not apply except in case of members who have paid dues as active members for at least 25 years, and who are now incapacitated from carrying on active work. It would seem like unwarranted lack of appreciation of the life work of such members to permit them to be dropped in their declining years.

Respectfully submitted,

CARLOS AVERY, *Secretary.*

The report was received and adopted.

REPORT OF THE TREASURER

To the American Fisheries Society:—

Herewith is submitted the annual report of the Treasurer covering the period from the last annual meeting held at Denver, Colorado, on August 17, 1925 to August 19, 1926, inclusive.

The past fiscal year of the Society has proved to have been one of the best that the Society has experienced in many years. This has been due to two principal factors—First, the addition of many new members through the activities of the President and Secretary and also several of our most staunch and interested members,—Second, to the activity of the Treasurer's office in constantly reminding the members of their financial obligations to the Society and appealing to them to maintain a paid-up membership both for their own sake and for the Society's revenue. The result of such a procedure has not only far exceeded our expectations but has, I am glad to state, completely liquidated the indebtedness under which we have been struggling for years. In other words, we have refunded to the Permanent Fund the past year $1,000 and wiped out our past borrowings from that fund and still paid all of our current expenses except a small amount due the Secretary and Treasurer part of which is on hand as a cash balance.

In my last report I suggested the advisability of exempting from dues the very few old members who have found it difficult to continue making payments but unfortunately the Society did not even take the matter

under consideration. For this reason we have been compelled each year to drop from the roll on account of non-payment of dues a few of our old loyal members—members that should have been retained on our list if there was any way to do so. The Treasurer therefore is urgently recommending that members who have paid their dues for 25 consecutive years may be transferred to the life-membership list. This is not only a reward for faithfulness, a procedure adopted in many other societies of similar character to our own, a means of retaining on our list our older members but also a procedure that should not affect the finances of the Society to any appreciable extent, even if any.

The number of such transfers to the life-membership list would only about balance the number lost each year on that list by deaths and other causes.

The following items are now presented for your consideration:

GENERAL FUND

Receipts

Balance on hand at meeting of 1925		$600.92
Annual Dues		
Individuals and Libraries		
For the year 1924	$31.00	
For the year 1925	1,155.88	
For the year 1926	24.50	
Clubs and Dealers		
For the year 1924	5.00	
For the year 1925	135.00	
For the year 1926	5.00	
State Memberships		
For the year 1925	140.00	
Life Memberships	50.00	
Sale of Publications	222.46	
Donations	173.00	
Exchange on checks	.15	
		1,941.99
Total Receipts		$2,542.91

Disbursements

Transactions, 1924, Vol. 54		
Printing of (750 copies)	$516.25	
Postage for mailing of, balance of bill	16.85	533.10
1925 Meeting at Denver, Colorado,		
Report proceedings of	285.00	
Printing programs for	22.50	307.50
Transactions, 1925, Vol. 55,		
Printing of (850 copies)	503.00	503.00
Expenses of Secretary's Office,		
Printing of stationery, circulars, applications and postage	74.88	74.88

Expense of Librarian,			
Printing of circulars	19.70		
Postage	16.32	36.02	
Expenses of Treasurer's Office,			
Printing of envelopes	28.00		
Postage, express and telegrams	16.16		
Premium of treasurer's bond	2.50	46.66	
Membership Refunds	3.00	3.00	
Transferred to Permanent Fund	1,000.00	1,000.00	
			2,504.16
Balance on hand			$ 38.75

PERMANENT FUND

Receipts

Balance on hand at meeting of 1925		$2,163.73
Interest to June 1, 1926	$66.58	
By transfer from General Fund on account of refunding in full	1,000.00	1,066.58
Total		$3,230.31

Disbursements

	0.00
Banance on hand	$3,230.31

Of the item of donations shown above, $168.00 was secured through a Special Membership Campaign. The expenses of such however are included under those of the Secretary's office, these being inseparable from the regular expenses of the society. The unused balance of $131.12 was turned over to the Permanent Fund.

Respectfully submitted,

T. E. B. POPE, *Treasurer.*

The report was accepted and referred to the Auditing Committee.

REPORT OF THE VICE PRESIDENT OF THE DIVISION OF FISH CULTURE

MR. FRED J. FOSTER (Missouri): Mr. President: An exceedingly embarrassing precedent was established at our last annual meeting held in Denver. Our honored fellow member, Dr. Emmeline Moore, then Vice President of the Division of Fish Culture, had the extreme temerity of rendering a written report for this division. Had the report been of average interest and thoroughness it might have lessened, to some degree, the embarrassment to her successors, but since Dr. Moore never has been satisfied to do things in an average way, she delved deeply into practically every phase whereon a report might be submitted. It is difficult to measure the fish cultural advancement of the nation as a whole in the short span of a single year, therefore it would be folly for one such as I to attempt to follow or add to the material she has so well presented to us.

Only one avenue of escape did Dr. Moore leave to a successor, that being the compilation of statistics as to hatcheries operated, number of persons engaged and total output of various species. The writer was comforting himself that therein lay his possibility of redemption and with a feeling of comparative safety made the fatal mistake of permitting the busy weeks to go until, without warning, a questionnaire of similar character was addressed to the various states from the office of another esteemed member, Mr. Leach. Most of us are familiar with the sinking sensation which comes of the sudden realization of opportunity lost through delay, and I feel therefore, that I have, at least, the sympathy of my listeners.

However, one happy thought still exists. Since part of the field has been so ably covered by Dr. Moore and the statistics previously referred to will no doubt appear in either one of the papers presented here or in bulletin form, then the necessity for further report is small indeed. To this may be added the fact that many of the papers to be presented at this meeting really form an exhaustive report of our year's achievement.

REPORT OF THE VICE PRESIDENT OF THE DIVISION OF COMMERCIAL FISHERIES

BY LEWIS RADCLIFFE

Mr. President: Upon being notified of my election as Vice President of the Division of Commercial Fisheries of this Society, my first thought was to take stock as to what I might do for the good of this organization. More than a year earlier I had suggested to the President

and Executive Secretary of the U. S. Fisheries Association and to members of this Society that an affiliation of these organizations should prove mutually beneficial. As this still seemed to be important its development was undertaken.

The purposes of the American Fisheries Society are well known to you. As the tenets of the U. S. Fisheries Association may not be so well known to the membership of this Society, you will pardon my dwelling for a moment on that subject. The objects of that Association include the securing of the "cooperation of the Federal Bureau of Fisheries * * * * * * and all the other Federal Departments or State agencies interested in conservation and propagation, and in the production and distribution of fish and sea food."

At the present time the U. S. Fisheries Association has about 1,500 members, including many of the most representative men in the fishing business. Their President, F. D. Fant, has endeavored to have State fish commissioners at the meetings of the U. S. Fisheries Association and at the Southern Fisheries Association in order that they might become better acquainted with each other, their problems and their aims.

In December, 1925, I submitted a tentative form of affilation to you and to Mr. Fant as follows:

TERMS OF AFFILIATION OF AMERICAN FISHERIES SOCIETY WITH THE U. S. FISHERIES ASSOCIATION

The American Fisheries Society and the United States Fisheries Association, recognizing the importance of closer coordination of effort in the husbanding and the more perfect utilization of the fishery resources of the United States, and realizing the strength in unity of action, do hereby affiliate on the following basis:

1. The American Fisheries Society shall be classed in the records of the United States Fisheries Association as an affiliated association member.

2. The United States Fisheries Association shall be classed in the records of the American Fisheries Society as an active association member.

3. A copy of each publication of the American Fisheries Society, whenever issued, shall be sent to the office of the United States Fisheries Association, and a copy of each publication of the United States Fisheries Association shall, whenever issued, be sent to the office of the American Fisheries Society, such exchanges constituting the consideration necessary for the legality of this agreement.

4. The President of the American Fisheries Society shall be made special advisor to the United States Fisheries Association in problems confronting the latter association in fish cultural and scientific lines. He shall act in this capacity until his successor has been chosen.

5. The President of the United States Fisheries Association shall be made special advisor to the American Fisheries Society in problems confronting the latter association, dealing with commercial fishing, and shall act in this capacity until his successor has been chosen.

6. Each of the contracting parties is empowered to send an accredited delegate to the annual meetings of the respective organi-

zations for the purpose of obtaining more complete and coordinate action on questions of mutual interest.

7. It is understood that each association shall have full authority to decide all questions both of fact and policy as each sees fit and that each shall cooperate with the other in so far as practicable in securing the maximum development of our fishery resources as a source of food and recreation for our people.

8. This affiliation shall take effect upon approval by the proper authorities of each association and shall continue in effect until one year from the date, when either of the high contracting parties shall give notice to the other of its desire to terminate the affiliation.

As the final results of negotiations, I have to report that under date of June 28, 1926, Mr. Fant wrote me in part as follows: "I submitted the matter of affiliation to the Directors in Savannah, and it was their unanimous opinion that the affiliation would be beneficial, both to the United States Fisheries Association and also to the American Fisheries Society. Therefore, we are ready and willing to carry out the plans for the affiliation, and if you will advise me what steps you desire me to take to consummate this affiliation, I shall be very glad to do whatever you suggest."

Subsequently, I mailed Mr. Fant an application membership blank of the American Fisheries Society and one of the U. S. Fisheries Association blanks to the President of this Society. In reply, Mr. Fant stated: "I have signed the application blank of the American Fisheries Society and have sent it to Mr. Hayford as requested. Just as soon as the application can be ratified either by Mr. Hayford and his directors, or by the American Fisheries Society, we can close the proceedings, as I have the sanction of the Board of Directors of this Association and no other action is necessary. I would like very much to report that this has been done at our convention in Philadelphia on September 15—18."

I wish to extend to Mr. Hayford and Mr. Avery my deep appreciation of their helpfulness in securing the approval of the officers of this Society.

In conclusion, it has been my experience that many of the differences between state and federal agents on the one hand and men in industry on the other are due to failure to get the other fellow's viewpoint; that when opportunity is afforded for representatives of the two groups to sit down together, differences are soon ironed out and harmony prevails. I believe that the affiliation of these two organizations will be very beneficial in the protection, conservation and utilization of our fisheries. I believe you will benefit by the support of the commercial fishermen and that they will benefit by the aid fish-culturists, fisheries biologists and others in this group can give them.

REPORT OF VICE PRESIDENT, DIVISION OF AQUATIC BIOLOGY AND PHYSICS

By H. S. Davis

In the short time at my disposal it has seemed inadvisable to attempt even a brief summary of the more important recent contributions to aquatic biology. It is thought that more can be gained by confining our attention to some phase of the subject which has a direct bearing on fish culture and in which we are all necessarily more or less interested.

During the last few years we have heard much about hydrogen-ion concentration and its effects on aquatic life. It is very distinctly a "live" subject which, I regret to say, has taken on many of the aspects of a fad; for, as you all know, biology like other sciences has its fads and faddists.

This sudden emphasis on the effects of hydrogen-ion concentration on fish and other aquatic life is largely due to the fact that in recent years chemists have developed a number of indicators which make it possible to determine the hydrogen-ion concentration of any body of water quickly and accurately. Another important factor has been the general adoption of a convenient method of expressing the hydrogen-ion concentration by means of the so-called pH values.

No doubt you are all aware that the hydrogen-ion concentration is simply a numerical expression of the acidity or alkalinity of a solution which replaces the vague and oftentimes meaningless terms formerly used.

It is unnecessary for our purpose to enter into a detailed discussion of the meaning of pH values. It is sufficient to remember that on this scale 7.0 indicates neutrality and that all readings below 7.0 are on the acid side and those above on the alkaline. Thus we have an accurate measure of the degree of acidity or alkalinity of any body of water which can be recorded and compared with those obtained elsewhere.

A large number of determinations of the hydrogen-ion concentration of natural waters have been made in recent years by various investigators. These tests have shown that there is a wide variation in the hydrogen-ion concentration largely due to differences in the quantity of inorganic substances in solution, to variable amounts of decomposing organic matter and the activities of aquatic organisms, and to the extent and kinds of pollution. Most potable waters are alkaline but there is abundant evidence that there are many natural waters unaffected by pollution which are more or less acid. On the other hand, with very few exceptions sea water is always alkaline and in contrast with fresh waters there is comparatively little variation in the hydrogen-ion concentration. For this reason we will confine our discussion to fresh waters where the fish are of necessity subjected to a considerable range in hydrogen-ion concentration. This range is, in reality,

a very large one since pH values from 4.4 to 9.5 have been obtained in natural waters containing an abundant fish fauna. When we remember that a sample of water having a pH value of 5.0 is ten times as acid as one of pH 6.0 and that one having a pH value of 9.0 is ten times as alkaline as one of pH 8.0 we realize the great variations in acidity and alkalinity fish and other aquatic organisms are subjected to under natural conditions.

While it is true that under ordinary circumstances the acidity or alkalinity of a body of water remains fairly constant we find that under certain conditions there may be a marked change in the pH value in a short space of time. For instance, it has been found at some hatcheries that water from the same source may vary from 7.5 to 9.5. This is due almost entirely to varying amounts of carbon dioxide in solution. Owing to their high carbon dioxide content spring waters are usually acid or only slightly alkaline but as a result of aeration and the activities of algae and other aquatic plants the carbon dioxide is removed and the water may become strongly alkaline. In fact we find that in many cases there is a direct correlation between the pH values in hatchery ponds and the amount of submerged vegetation, the greater the amount of vegetation the higher (more alkaline) the pH value.

Since there is such a wide range in the hydrogen-ion concentration in natural waters and in those of our hatcheries it is of great importance to the fish culturist to determine if these variations have any appreciable effects on the fish for good or ill. Shelford, who has devoted much time to investigations on the effect of hydrogen-ion concentration on aquatic organisms, concludes that "each species" (of fish) "tolerates a rather wide range with a fairly definite optimum". Coker determined the hydrogen-ion concentration of natural trout streams in North Carolina and eastern Massachusetts and found they were all neutral or slightly acid. In the North Carolina streams the water became more or less alkaline in the lower sections where the trout were replaced by sunfish, bass and other fishes. Only two species of fish, the black sucker *(Catostomus nigricans)*, and the black-nosed dace *(Rhinicthys atronasus)* were found associated with the trout and he suggests that this may be due primarily to the acidity of the water.

On the other hand the writer has found that trout brooks in the vicinity of Rutland, Vermont, range from pH 7.4 to 8.0 and it is believed that all trout streams in the vicinity, which includes some of the finest in the State, are normally alkaline. In some of these streams only trout occur while in others they may be associated with the black-nosed dace, a sculpin *(Uranidea gracilis)* and occasionally with suckers.

In this connection the recent studies of Brown and Jewell on the fishes of Vincent Lake, Michigan, are of special importance. This Lake has the unusual combination of a high acidity, pH 4.4, combined with an abundance of oxygen, about 70 per cent of saturation. Four species

of fish, the yellow perch, bullhead, bluegill and pike occur in the lake and all except the pike are quite abundant. Evidently these fish are thriving in waters which according to some writers are sufficiently acid to be quickly fatal to all fish life.

It may be argued that the fish of Vincent Lake have in the course of years become acclimated gradually to this high acidity and form a strain physiologically distinct from fish of the same species found in ordinary waters. To test this hypothesis Brown and Jewell transferred fish from the alkaline waters of Douglas Lake, having a pH value of 8.6 to Vincent Lake, and also fish from Vincent Lake to Douglas Lake. In all cases the fish survived the transfer and, so far as could be determined, suffered no ill effects.

It was also found that when given the opportunity fish normally select water having approximately the same pH value as that to which they have been accustomed. Thus when fish were placed in a gradient tank supplied at one end with water from Vincent Lake and at the other end with water from Douglas Lake those from Vincent Lake selected the acid end of the trough while fish from Douglas Lake selected the alkaline end. Trout which had been held in water having an intermediate hydrogen-ion concentration selected the middle of the gradient.

In view of these facts I believe we may conclude that under ordinary circumstances the direct effect on fish of hydrogen-ion concentration as such is of minor importance. Other factors such as temperature and the oxygen and free carbon dioxide content of the water have a much greater influence than has the hydrogen-ion concentration.

Of course this does not mean that the fish culturist should ignore entirely the hydrogen-ion concentration. The fact that fish tend to select the hydrogen-ion concentration to which they have been accustomed indicates that it may, in some cases at least, exert an important influence on their distribution and migrations. There is also evidence that the hydrogen-ion concentration is of much greater importance in the economy of many aquatic invertebrates and algae and that consequently its indirect influence on fishes may be considerable. It is well known that hard waters are usually more productive than soft waters and while the hydrogen-ion concentration is only one of several factors involved it is undoubtedly an important one. But it would take us too far afield to attempt a discussion of the effects of hydrogen-ion concentration on the plankton and other organisms in fresh water. It is sufficient to point out the great need of further investigation in this field, which is only one of the many problems in aquiculture on which further light is required before we can utilize our aquatic resources to the best advantage.

REPORT OF THE LIBRARIAN

MR. JOHN W. TITCOMB (Connecticut): Mr. President, as Librarian, I am custodian of all the reports that have been published. The Society has not a complete set of its own publications, which are increasing in value as time goes on. Some members do not read these reports and eventually they go into the waste basket. Others read them with a good deal of interest but do not preserve them. We could sell many copies of the missing numbers to libraries. There is an increasing interest on the part of libraries to have these publications, because they contain information which cannot be found in any other publications, setting forth, as they do, the progress made in fish culture from year to year. We lack for the Society's library file, copies for 1873, 1874, 1875, 1877, 1894, 1899, 1905. The 1905 copy is quite a valuable one; I mention this because some of you may happen to have or run across these old publications. When some old member passes on I have tried to obtain these copies through their estates, but thus far have not been successful.

Every member of the Society in good standing is mailed a copy of the Transactions as soon as received from the printer. Those who are in arrears two years, for dues, do not receive the Transactions. Until about two years ago, it was customary to mail the Transactions to every member on the list whether his dues were paid or not. As a result the Society was out of pocket a good deal of money. All those who received the 1925 Transactions got with it a letter explaining about the separate copies of the quarterly Transactions, as they were for a time issued quarterly instead of annually. During that period surplus copies of many quarterlies accumulated. Rather than put them in the waste basket we are offering them at ten cents a copy.

We have had calls from some libraries and scientific institutions which thought we ought to furnish them free of charge, but we have not felt that the Society was in a financial position to do that. Most of its members are men who work for very much less money than they earn. We know that the fish culturists of the country as a rule are underpaid—men of special experience, special lines, who have got their knowledge by hard work, yet they are the ones who are supporting this institution to a large extent. So I cannot see why these scientific institutions and libraries should not pay for the Transactions just as these fish culturists do, a large percentage of whom are unable to attend these meetings but maintain their membership purely for the purpose of receiving the Transactions.

REPORT OF THE COMMITTEE ON INTERNATIONAL RELATIONS

This committee, after making a survey of international conditions, believes it advisable to confine its report to a single matter of importance. This refers to the negotiation of a new treaty between Canada and the United States looking to the adoption of uniform commercial fishing laws and regulations in international boundary waters.

On the matter, some time ago, Hon. J. F. Gould, Commissioner of Game and Fish, Department of Conservation, State of Minnesota. reported:

"On April 11, 1908, a treaty between Great Britain and the United States was signed at Washington and the ratification of this treaty was advised by the Senate on April 17th, and ratified by Great Britain on May 9 and was proclaimed adopted July 1, 1908.

"This treaty provided for the appointment of an International Fisheries Commission consisting of one person named by each Government and it was made the duty of this Commission to prepare a system of uniform and common international regulations for the protection and preservation of the food fishes in certain waters enumerated in the Third Article of said treaty, most of which waters are international boundary waters between Canada and United States.

"By this treaty the two Governments engaged to put into operation and to enforce by legislation and executive action the regulations, restrictions and provisions that might be adopted by these Commissioners.

"Thereafter commissioners were appointed and on the 29th of May, 1909 these commissioners filed their report and on February 2, 1910, President Taft submitted this report to Congress, which contained the regulations and rules that were adopted by said Commissioners. In submitting this report to Congress, President Taft stated,—

> **'The regulations are submitted to Congress in order that due legislative action on the part of the Government of the United States may be taken as stipulated for in Section 3 of said treaty or convention.'**

"I am informed that the Canadian Parliament passed the necessary legislation to carry these regulations into effect but that the Congress of the United States has never done so. I am further informed that Canada abrogated the treaty of 1908, in the year 1914.

"I find that bills were introduced in Congress from time to time to provide for the adoption of these regulations but that such bills failed of passage.

"Of course further consideration of action under the original treaty of 1908 and the report of the Commissioners of 1909 which was referred to Congress by President Taft in 1910, is out of the question at this time because of the abrogation of the provisions of the treaty by Canada.

"The fresh water area along the international boundary is extensive and their fisheries are important, producing about one hundred million pounds annually. It is indeed difficult to control and conserve these fisheries so long as so many different authorities have a part in exercising such control. For example, control of the fisheries of Lake Erie is divided between four States, the Province of Ontario, and the Dominion government. In so far as the State of Minnesota is concerned the waters of Lake of the Woods, Rainy Lake and others, and the control of the fishing operations therein, are exercised by the Domin-

ion of Canada, the Province of Ontario and the State of Minnesota, and the Minnesota commercial fishing laws on the subject—in but few particulars—harmonize with those of the Dominion and Province and in my humble opinion the difficulties of maintaining and husbanding the fisheries of Minnesota are almost insurmountable and fishing regulations therein must be placed upon the same uniform basis, and their enforcement handled by some one authority. If some step to this end is not undertaken and accomplished at an early date the fisheries are seriously threatened with exhaustion in such waters.

"My further opinion is that the only workable remedy for such prevailing conditions is the setting up of a commission between the two governments which shall be given ample authority to study the fisheries and to make such regulations as it finds necessary for the safe-guarding of the rapidly diminishing supply. The water being international the Commission would necessarily have to be international to serve its purpose.

"My information is that even the commercial fishing interests have come to realize the utter futility of proceeding further under existing conditions and I venture to say that public sentiment in both Canada and United States can easily be aroused to such a point as to insure the enactment of an adequate treaty."

Our Committee is impressed with the need of immediate action along the lines suggested in Commissioner Gould's summary of the present situation, and the Committee has handed to the Committee on Resolutions the draft of a resolution to cover the foregoing.

Respectfully submitted,

WILLIAM C. ADAMS, *Chairman.*

MR. AVERY: Under the provisions of the by-laws of the Society as amended at the last annual meeting, no expenditure for clerical services is permitted unless authorized by vote of the Society. That is a very wholesome provision, because it safeguards the Society against any extensive expenditures of that character. But the meeting last year at Denver adjourned without making any provision whatever for such expenses for this year, therefore there has not been a dollar spent during the past year for any such services. Certain small expenditures for these services, however, are necessary in the offices of the Treasurer and the Secretary, and to some extent in some of the other offices, and in order that this, and other matters in connection with the finances of the Society, may be properly canvassed and intelligently acted upon by this meeting. I move that a committee of three on finances be appointed.

The motion was seconded and agreed to.

APPOINTMENT OF COMMITTEES

The following committees were appointed by the President:

Committee on Nominations: E. Lee LeCompte, Chairman; G. C. Leach, E. A. Tulian, D. E. Pettis, Chas. R. Pollock.

Committee on Time and Place: Lee Miles, Chairman; James A. Laird, Thaddeus Surber, M. D. Hart, W. E. Albert.

Committee on Program: John W. Titcomb, Chairman; Frederick J. Foster, I. T. Quinn.

Committee on Resolutions: George C. Waggoner, Chairman; Keith McCanse, George Berg.

Auditing Committee: C. F. Culler, Chairman; J. B. Doze, A. R. Reeves.

Finance Committee: John W. Titcomb, Chairman; Carlos Avery, I. T. Quinn.

REPORT OF THE COMMITTEE ON TIME AND PLACE

LEE MILES, Chairman: It has been the practice for several years for the American Fisheries Society to hold a joint session with the International Association of Game, Fish and Conservation Commissioners. Your committee on Time and Place held a joint meeting with the Time and Place committee of the International Association and have selected Hartford, Conn., as the place of meeting, the time to be the second Monday in August. I move you the adoption of this report.

The report was adopted.

PRESIDENT HAYFORD: I wish to call attention to a suggestion made by Mr. Surber. It is that the heads of State departments should buy for each one of his fish culturists a copy of the annual Transactions of the Society, to remain the property of the State and to be kept at the hatchery in order that the fish culturists may have the information available to them when required. I quite agree with Mr. Surber that it is just as much a part of their equipment as the tools and brushes that they have to work with. It would bring us a lot of new members, and we would be getting every fish culturist in America interested in what we are doing.

SECRETARY AVERY: You will recall the proceedings instituted by the U. S. Department of Justice against certain fish dealers in New York City. This has been followed by an-

other proceeding against another group of dealers who handle live fish only. The federal court in its findings has directed that two railway cars equipped for handling live fish shipments shall be sold at auction and I have been requested to call attention at this meeting to the terms and time of sale. The U. S. district attorney's office of New York City has asked that the notices of this sale which I have here be called to your attention, also the decree of the court.

Inquiries as to the character of the cars, their value, and names of live fish dealers were answered.

REPORT OF THE FINANCE COMMITTEE

To the Officers and Members of the American Fisheries Society:—

Your Committee on Finance begs leave to report as follows:

We recommend that allowance be made for expenses for clerical service in the office of the Treasurer of $50.00 for the year 1925-6 and not to exceed $75.00 for the year 1926-7.

For clerical services in the office of the Secretary, $50.00 for the year 1925-6, and not to exceed $75.00 for the year 1926-7.

For clerical services in the office of the President and Librarian, not to exceed $50.00 for the year 1926-7.

We recommend the appropriation of $10.00 for contribution covering membership of the American Fisheries Society in the National Conference on Outdoor Recreation, for the current year.

We recommend that the income from the Permanent Fund of the Society be used in the payment of prizes for papers representing the results of original research work by members, as was formerly done, but which was discontinued because of the depleted finances of the Society.

We recommend that preparation be made for publication of a catalogue and index of the publications of the Society by soliciting subscriptions for the same from libraries, clubs and individuals, and that appropriation be made therefor as soon as the librarian is assured of sufficient support.

We recommend that the constitution and by-laws be amended to authorize the President, Secretary and Treasurer to transfer members from the active to the life membership list at their discretion for good and sufficient reason, provided that no member shall be so transferred unless he shall have paid dues as an active member for at least twenty-five years.

Respectfully submitted,

JOHN W. TITCOMB, *Chairman.*
I. T. QUINN,
CARLOS AVERY.

On motion of Mr. Reeves, seconded by Mr. Pettis, the report was received and adopted.

MR. TITCOMB: I wish to submit a proposed amendment to the constitution and by-laws, as follows:

The constitution and by-laws of the American Fisheries Society are hereby amended as follows:

By adding to Paragraph Six (6) of Article 2 relating to life membership, the following:

The President, Secretary and Treasurer of the Society are hereby authorized to transfer members from the active list to the list of life members at their discretion for good and sufficient reason, such as inability to pay dues, provided that no member shall be so transferred unless he shall have paid dues as an active member of the Society for at least twenty-five years.

In presenting this amendment, Mr. President, I feel that I can do so without any lack of modesty, for the reason that I paid my dues for thirty years and then took out a life membership. (Applause.)

On motion of Mr. Quinn, seconded by Dr. Moore, the amendment was adopted unanimously, there being more than fifteen members present and voting.

REPORT OF THE AUDITING COMMITTEE

We, your auditing committee, have examined the books and records of the treasurer and beg leave to report that the same are in proper balance, correct in form and neatly kept.

Mr. T. E. B. Pope the treasurer is entitled to the thanks of the Society for the neatness with which he has kept the records and for his efficiency and painstaking care and personal sacrifices in handling the affairs of his office.

The report of the auditing committee was accepted.

REPORT OF THE COMMITTEE ON RESOLUTIONS

INTERNATIONAL RELATIONS

Resolved, That the American Fisheries Society in annual convention assembled, unanimously favors action by the Secretary of State of the United States relative to the negotiation of a new treaty between Canada and the United States looking to the adoption of commercial fishing laws and regulations in international boundary waters. To this end the Secretary of State is urged to institute the necessary proceedings looking to the appointment of an International Fisheries Commission to make a study of the situation to the end that a report

may be made to the United States Senate at the next session of Congress.

Further resolved, That the American Fisheries Society hereby approves the efforts of the Department of Commerce through Secretary Herbert Hoover in bringing about a better understanding between Mexico and the United States with regard to fishing rights. That Secretary Hoover be advised of the interest and approval of this Society and that the Hon. Secretary of Commerce be earnestly entreated to secure from Congress the necessary funds to permit the United States through the Department of Commerce and Bureau of Fisheries to carry out the provisions of the existing treaty between the United States and Mexico so as to meet the Mexican delegates on an equal footing.

Further resolved, That a copy of this resolution, together with a copy of the report of the Committee on International Relations, be forwarded to the Hon. Frank B. Kellogg, Secretary of State, Washington, D. C.

Attendance of United States Fisheries Bureau Representatives at Meetings of the American Fisheries Society

WHEREAS, it has been the custom of the U. S. Commissioner of Fisheries, through the approval of the Secretary of Commerce, to authorize the attendance of some of the Bureau's employees, including superintendents of hatcheries and the Bureau's pathologist, at annual meetings of the American Fisheries Society, and

WHEREAS, contributions made by such delegates in attendance have added materially to the value of the published Transactions of the Society, and

WHEREAS, the Society is a purely altruistic one, national in scope and anxious to promote the cause of fish culture and all matters relating to the fisheries, including all questions of scientific and economic importance, and whereas a recent ruling has prevented the usual attendance of the Bureau's representatives, an appeal is hereby made to the Secretary of Commerce and the Commissioner of Fisheries that they use their best endeavor to secure an adequate attendance of the Bureau's employees at future meetings.

Sale of Unlawful Contrivances

WHEREAS, many of the large catalogue houses which engage in interstate commerce, list, picture and sell nets, seines, gigs, fishtraps and other contrivances for catching fish that are in violation of the State laws and the general program of conservation,

Be it resolved, That this Society protest this practice and petition these firms to discontinue this practice, except in case the Game and

Fish Department of the state from which the order comes may endorse same;

WHEREAS, we believe the management of said catalogue houses are interested in the program of conservation of fish and game,

Be it resolved, That a committee of two be appointed by the President of the American Fisheries Society to bring this to the attention of said firms.

HYDRO-ELECTRIC POWER PROJECTS

WHEREAS, through the erection of great dams in the various sections of the United States the purpose of which is to harness the streams for hydro-electric power, often to the detriment of the fish and other aquatic life that inhabit the same above and below such dams, and

WHEREAS, noticeable losses have occurred where streams have been completely despoiled and fish killed by interfering with the normal flow of water through such power dams, or by stopping the flow entirely at times, thus destroying the fish or greatly interfering with their spawning above and below such dams, and

WHEREAS, little attention is now given to this serious menace for the preservation of fish in many states of the Union, therefore

Be it resolved, That this Society call attention to such menace and recommend that proper legislation be enacted by such states as have not already fully safeguarded the interests of the public as to their rights to the fish in the public waters.

DUTY ON GAME BIRDS

WHEREAS, we appreciate the slight reduction made in the duty on imported game birds, as per the resolution of the Denver meeting of this Association,

Be it resolved, That a representative of this Society be appointed to serve with those appointed by the International Association of Game, Fish and Conservation Commissioners to not only seek complete abrogation of said duty, but to secure from the Government a refund of duty heretofore paid by the states which have purchased game under this tariff regulation.

APPRECIATION

WHEREAS, Commissioner I. T. Quinn and other worthy citizens of Alabama, also the press and the managers of The Battle House Hotel at Mobile, have made our sojourn here comfortable, pleasant and profitable,

Be it resolved, That we express our sincere appreciation by a standing vote, wishing them joy, success and prosperity in their future strides of civic and industrial life.

Be it further resolved, That we express our hearty thanks to President Charles O. Hayford and his cabinet for the untiring and efficient services they have given for the welfare of this organization and for the drafting of this session's valuable program.

On motion of Mr. Reeves, seconded by Mr. Titcomb, the resolutions were unanimously adopted.

REPORT OF THE COMMITTEE ON NOMINATIONS

OFFICERS FOR 1926-27.

President ..... JOHN W. TITCOMB
Vice-President ..... DR. EMMELINE MOORE
Secretary ..... CARLOS AVERY
Treasurer ..... T. E. B. POPE
Librarian ..... JOHN W. TITCOMB

Vice-Presidents of Divisions:

Fish Culture ..... FRED J. FOSTER
Aquatic Biology and Physics ..... DR. H. S. DAVIS
Commercial Fisheries ..... LEWIS RADCLIFFE
Angling ..... W. C. ADAMS
Protection and Legislation ..... LEE MILES

Executive Committee:

CAPT. C. F. CULLER, *Chairman*
E. LEE LECOMPTE
E. A. TULIAN
WM. F. KEIL
J. A. RODD
THADDEUS SURBER
JAS. A. LAIRD
CHAS. R. POLLOCK
WM. C. ADAMS

Committee on Foreign Relations:

DWIGHT LYDELL
HONORE MERCIER
HENRY O'MALLEY
JAS. F. GOULD
DR. V. K. IRION
J. B. DOZE

Committee on Relations with National and State Governments:

GEO. M. MANNFELD
I. T. QUINN
D. E. PETTIS
J. B. ROYALL
MAX HART
C. B. PETERSON

On motion of Mr. Reeves, seconded by Mr. Viosca, the report was unanimously adopted.

PRESIDENT HAYFORD: The officers are hereby declared elected as read. I will appoint Mr. Quinn and Mr. Tulian to escort the new President to the Chair.

RETIRING PRESIDENT HAYFORD: John W. Titcomb, your new President, needs no introduction, because he is one of the oldest members of the Society and one of the best informed men in America on matters relating to fish and fish culture. I will now turn the Chair over to your new President.

PRESIDENT-ELECT TITCOMB: Fellow members of the Society, I want to assure you that I am not unappreciative of this honor. I am breaking a record, perhaps, of the last twenty-five years, by being reelected President of the Society. I was elected President at the Niagara meeting, I think it was in 1899. At that time for a series of years there was a little ring of a few commissioners who year after year passed among themselves the offices of President and Secretary. When I arrived there I was told that they wanted me to break the ring. I think it is a safe rule not to elect the same man as President a second term, on the other hand, if you elect a President for the second time only after an interim of twenty-five years you will be quite safe.

I have been a member of the Society since 1892. I think that all of the Presidents who served before I was elected have gone to the great beyond. I have seen a great many changes in the personnel of this Society. It is difficult for me to express myself in regard to them. They were earnest workers, just as you are, doing what they could for the good of the nation. My only wish is that we could have more of them and that they be more properly compensated; that the commissioners of all the states would appreciate the value of these meetings and see that their fish culturists are present, or at least that they have copies of the Transactions. I hope to greet all of you and many others at the meeting to be held in Connecticut next August.

MR. TULIAN: Mr. President, I wanted to say that Dr. Irion phoned me this morning and asked me to tell you how much he regretted that he was not able to come. He went to the station to get his ticket and they would not sell him one. He could not walk; he did not have an aeroplane, so he is not here.

PRESIDENT-ELECT TITCOMB: I am sure we are very sorry indeed that the elements conspired against him and kept him away, as it did many others. Dr. Irion is a mighty fine man and takes a great deal of interest in this work.

MR. POLLOCK: I have come a long way to attend this meeting. I have known about your meetings for several years, but this is the first opportunity I have had to attend one.

A great deal of your fish cultural work is something that we in Washington are not so much interested in, because we do not handle the same kind of fish; at the same time I have gathered a great deal of valuable information here. I was especially interested in the talk we had yesterday morning on pollution, given by the gentleman from Louisiana. I do not know whether it is proper for me as neophyte to offer a suggestion, but I would appreciate it very much if there could be at your next meeting in Hartford a symposium on the pollution question, in order that every state which is interested—and every one is, if they only knew it—may have ample opportunity to discuss the matter. That is one thing that the whole country has a vital interest in, and that interest will increase from year to year. Our state departments of health have been working on the matter, and I have right now two or three men in the field to do some preliminary investigations in connection with the new pulp mills that are either starting or are being promoted in the State of Washington. On account of the depletion of the resources in other states they are all heading our way, and both Oregon and Washington are getting very active in working on this pollution matter.

Another matter that should be taken into consideration is the fishway proposition. You people have had some trouble here in that respect, and we in the West are right up against it at the present time. Every one of our dams is going to be from one hundred to three hundred feet high and the problem is a very serious one with us. We are conducting an experiment this year on a 240 foot dam. We have put 3,600 sockeye salmon over this dam. Our Department has not given this fishway or tramway absolute approval, but so far as our observations show, it is seventy-five per cent efficient. I have not the time, and you do not want me to take the time, to go into this matter in detail, but I think it is a subject that is worthy of consideration at your next meeting. If I cannot be there myself I hope to be able to have one of our men, or two men report on our work on these two lines—pollution, and fishways. I hope we shall have something very important that will be of value to you.

Then there is one other suggestion I wish to make before I sit down. Oregon, Washington and British Columbia work together on a great many things, especially in the matter of bringing tourists to our country. We hope that in 1928 your Society will be able to meet with us on the coast. We are not going to ask you to meet in Seattle, Portland, or

Victoria; that is just as you wish. But we can start you in Victoria—your round trip ticket will not cost you any more to go one way or the other—or you can meet wherever you decide. But we want you to seriously consider meeting in the Pacific Northwest in 1928. The last meeting you had in the West was in San Francisco, I think in 1915. I have given your secretary a letter from Mr. John Babcock, who has been interested in the fishing business as a British Columbia employee for the last forty years; several others on the coast have been in this propagation work for the same length of time, and they are all very anxious that the Association shall meet again on the coast in the near future. I think your secretary also received several telegrams from both Washington and Oregon. We are ready to put over any kind of program you think you can have there. If you can come to one place, all right; if you would like to go to the three we have the facilities to take care of you.

At your meeting on the 22nd one of our fish firms—Booth Fisheries—had planned to send you a little tidbit for the meal on the boat. The boat excursion was delayed, and the tidbit did not arrive until this morning. There is one box up here, and I hope each one of you will take your share and eat it with your noon lunch. (Applause.)

PRESIDENT-ELECT TITCOMB: I am sure you have all been interested to hear Mr. Pollock, who comes from a very important part of our country in the fishery industry. We will appreciate having representatives from the coast present papers on subjects of importance such as the fishways, which certainly must be a live question out there. I may say that the members who had the opportunity of attending the meeting on the Pacific coast will never forget it. It was a very profitable meeting in many ways; in fact, this sinking fund which has just been restored to a normal condition was subscribed by the Associations on the Pacific coast through the packers and the branch clubs there, and it has been very useful to us in time of need. We hope to maintain it and increase it so that the revenue from it can be used, as indicated by the resolution passed to-day.

MR. QUINN: Mr. President, before we adjourn I want to express to you ladies and gentlemen once more the great pleasure that it has given Alabama and Mobile to have you with us for your 1926 meetings. I believe earnestly that the meeting in Alabama this year will mean a great deal for the future development of conservation work in this State. Words fail me in expressing my appreciation of your visit

here, and in return for the fellowship and friendship that has moulded us into a more closely united body, comprising representatives from all sections of the Union, I expect to appear with you, Sir, at Hartford, on the second Monday of next August with an Alabama delegation. (Applause.)

Whereupon the Fifty-sixth Annual Meeting of the American Fisheries Society adjourned.

In Memoriam

THURSTON BALLARD

G. M. WILLARD

DWIGHT LYDELL

WILL H. DILG

PART II

PAPERS AND DISCUSSIONS

SMALL-MOUTHED BLACK BASS PROPAGATION

By Dwight Lydell

Assistant Superintendent of Hatcheries, State of Michigan, Comstock Park, Michigan.

In the propagation of small-mouthed black bass a primary essential is that the breeding stock be in proper condition. Either partial or complete failure usually results when the fish culturist forgets his breeders as soon as the spawning season is over. Success in this respect will be attained, however, when adequate consideration is given to the breeding bass upon completion of the spawning season of one year and in anticipation of spawning in the following year. As we all know, the roe for the following year is present and starts to develop immediately after spawning takes place. It is certain that to secure the normal development of the roe the fish must be well fed and in the pink of condition when they go into winter quarters in the fall. A large and hardy crop of fry is then obtained the following year.

The method followed here is to start feeding the adult breeders as soon as the fry are screened. They are fed every day until they go into winter quarters; they are not only fed but are given all the food they want. During the summer months clam meal is the chief food, while in the fall, after the fish are put in the wintering ponds, there is introduced a generous supply of crawfish and minnows. In fact we introduce enough to last until the stock of breeders is sorted the following spring.

After the breeding ponds are cleaned the nests are put in place and the ponds are filled with water. The flow of water is shut off every night and turned on during the day only when the sun shines. In that way the water is made as warm as possible before the fish are introduced. It has been found that if a temperature of 67 or 68 degrees Fahrenheit can be secured in the ponds before the bass are introduced they then spawn quickly and all nests are usually occupied.

There are various sizes and shapes of ponds here, but the best results over a period of several years have been in those that are egg-shaped, about 150 feet by 180 feet,

with shores running from a feather edge to the kettle, which is usually five feet deep. The nests are placed approximately 25 feet from shore, and the best results have been in about two feet of water. The old nests and fry containers are still being used. Screens are used if for no other reason than to control the number of fry released in each pond, which of course depends on the available natural food supply.

Some fish culturists are placing too many nests in their ponds. In former years many more nests were put in each pond than at the present time, but now we are using fewer breeders and are getting more fry. The numbers of nests set here are about as follows: pond No. 7, 125 by 185 feet, 15 nests; pond No. 8, 150 by 180 feet, 20 nests; pond No. 9, 135 by 145 feet, 20 nests; and Island Pond, 130 by 360 feet, 26 nests. These examples give an idea of the ratio of nests set to water areas throughout our entire pond system.

Breeders are held in the wintering ponds from fall until sorted for breeding ponds in the spring. There is as large a flow of water passing through each pond as possible, and, where available, spring water is introduced to keep them as cool as practicable.

In putting the breeding stock into the breeding ponds it is essential always to assort the fish to uniform size for each pond. If there be small breeders and they are placed in a pond by themselves, better results will be obtained. In sorting small-mouthed bass for the breeding ponds we always put in a couple of extra females and the reason for this is known to all fish culturists who have read any of our former articles on breeding fish.

Following is a list of the nine ponds used at this station in the season of 1926 for breeding purposes:

Pond	Males	Females	Nests set	Nests producing fry
No. 3	10	11	10	7
No. 7	15	16	15	14
No. 8	20	22	20	20
No. 9	20	23	20	20
No. 13	16	17	16	14
No. 14	15	16	15	14
No. 15	15	16	15	13
No. 16	15	16	15	15
Island	26	29	26	25
Totals	**152**	**166**	**152**	**142**

It will be noted that in these nine breeding ponds there were introduced 152 male and 166 female small-mouthed bass, and 152 nests were set, of which 142, or over 93 per cent, were successful in producing fry.

In addition to the above-mentioned nine ponds which were used for breeding purposes and thereafter for rearing, six other ponds were stocked with fry from the breeding ponds and used for rearing purposes only. After all these ponds were supplied to capacity with fry for rearing to fingerling size 688,000 surplus fry were removed and distributed to public waters.

The number of fish distributed from each pond since then to date (September 11, 1926) has been as follows:

BREEDING PONDS

Pond	Fingerlings No. 1	Fingerlings No. 2	Fingerlings No. 3	Total
No. 3	13,400	400	.....	13,800
No. 7	29,400	2,800	1,700	33,900
No. 8	35,000	4,800	1,300	41,100
No. 9	22,700	2,800	500	26,000
No. 13	19,500	3,200	2,775	25,475
No. 14	20,250	1,800	1,325	23,375
No. 15	19,500	11,400	4,350	35,250
No. 16	10,200	5,400	5,150	20,750
Island	27,700	3,800	1,500	33,000
Total	197,650	36,400	18,600	252,650

STOCKED PONDS

Pond	Fingerlings No. 1	Fingerlings No. 2	Fingerlings No. 3	Total
No. 2	.....	.....	400	400
No. 4	7,000	3,400	1,300	11,700
No. 17	5,100	4,200	300	9,600
No. 18	2,500	.....	.....	2,500
No. 19	4,000	4,800	.....	8,800
No. 20	11,500	11,800	.....	23,300
Total	30,100	24,200	2,000	56,300

The foregoing tables do not show the complete yield of fish as the ponds yet remain to be cleaned up before figures will be available for the total season's output. As good results are obtained in rearing fry in the breeding ponds as in the rearing ponds provided the adults in the breeding ponds are well fed every day.

In order to insure having an almost unlimited amount of natural food for the fry, it has been our custom to draw the ponds in the fall and leave them until they are thoroughly frozen out. During this period all vegetation, mud, silt, etc., are flushed out of the ponds. The ponds are then refilled. They are again drawn down in the spring to assure us that there is nothing left there to prey upon the young fish. The ponds are left dry for several days, when if necessary they are treated with a fertilizer; nests are then set and the ponds refilled with water. They are then ready for the breeding stock. Fertilizers used have been either clam meal or clean fresh horse manure. Ponds the size of No. 7, which is 125 by 185 feet, if treated with clam meal, receive about 75 pounds. If horse manure is used, one big wagon load is sufficient. Results obtained are about equal in stimulating the growth of natural food. A reason for filling our ponds during the winter months is that due to soil formation the frost heaves raceways and other structures out of place.

To sum up the whole matter, success in breeding and rearing small-mouthed bass depends chiefly upon (a) condition of breeding stock, (b) sorting as to sizes in the ponds, (c) temperature, and (d) natural food supply.

RAISING TROUT IN BASS PONDS AND PERCH IN BLUE GILL PONDS IN THE SAME SEASON

By Dwight Lydell

Assistant Superintendent of Hatcheries, State of Michigan, Comstock Park, Michigan.

Some interesting experiments were carried on at the Mill Creek station in Michigan in 1926 in the use of ponds for producing two crops of different species of fish from the same body of water. The capacity of a hatchery can thus be increased considerably and more efficient use can be made of the equipment. Those in charge of hatcheries will be well repaid for trying these experiments as they cost practically nothing and take no extra equipment. A description of these experiments and the results obtained is given below.

PERCH AND BLUE GILLS

In the experiment of raising perch and blue gills in the same waters in one season, Pond A, 135 by 245 feet, and Pond B, 100 by 260 feet, were used. In the following, these two ponds will be treated as a unit.

Previously, Ponds A and B had been used only for raising blue gills which were generally introduced during the month of June, and the thought occurred as to why these waters could not be utilized also for something during the months of April and May. The perch spawn in this locality as soon as the ice disappears from the inland waters. Thus, on April 30, 1926, three quarts of eyed eggs were placed in these ponds after they had been cleaned and fertilized in the same manner as all ponds used at Mill Creek for starting young fry to the fingerling stage. On June 8, as the time had arrived for blue gill work, the ponds were drawn and 111,500 fine No. 1 perch were collected and distributed to inland waters.

The ponds were then cleaned, fertilized with four yards of fine horse manure, filled with water, and blue gill fry were introduced. These were taken out and distributed during the month of September, the number being 137,000 No. 2 fingerlings. Plenty of natural food was available, but after the first 30 days, they were fed twice daily with finely ground clam meal. The meal used at first was put through a copper wire cloth, forty wires to the inch. The

size of the food was increased from time to time as the fish developed.

The temperature of these ponds was controlled by shutting off the water on cold days or evenings, and turning it on only when the natural supply was warmer than 60 degrees Fahrenheit. In fact, no water was allowed to run over the spill-way until the fish had reached a size when they could not go through a twenty mesh wire cloth. Temperature records were not kept for these two ponds, but the ranges were from 58 degrees to 75 degrees Fahrenheit.

This undertaking, if properly carried out, will almost double the output of any suitable pond. It was tried in a smaller way during the season of 1925 by Mr. Claud Lydell at the State hatchery at Hastings, Michigan, and full credit for the work should be given to him as the Mill Creek experiment was only a check on what he had already accomplished.

BASS AND RAINBOW TROUT

For the experiment of rearing trout in waters which earlier in the season of 1926 had yielded an output of bass, Pond No. 16 and Pond No. 17 were selected.

From Pond No. 16, which is 110 by 200 feet, there were reared and planted 20,750 fingerling bass of which 10,200 were No. 1, 5,400 No. 2, and 5,150 No. 3. In Pond No. 17, 9,600 No. 2 fingerling bass were reared from 10,000 fry. This pond is 160 by 175 feet and 4 feet deep at draw-off, and had not been used as a breeding pond. Both of these ponds were drawn early in the spring and cleaned and fertilized in the usual manner for rearing purposes. The last of the fingerling bass were taken out and distributed August 18.

On August 20, these ponds were thoroughly cleaned and 75 pounds of clam meal put in each as a fertilizer, it being sown around the shores from the edge of the water to about 20 feet out. They were then filled with water. On August 25, the ponds were teeming with daphnia and other water fleas. In fact, they were so numerous that the bottom of the ponds could hardly be seen. This was somewhat remarkable as it had been believed that such food could only be produced in the spring months.

On August 27, 5,000 rainbow trout about 1 inch in length, from the State hatchery at Paris, Michigan, were released in these two ponds, but the number in each pond was not

counted. On October 29, the ponds were drawn and 4,246 rainbows averaging 3½ inches in length were removed. They were in excellent condition, the result of having plenty of natural food in addition to the clam meal which was fed each day after the first twenty days.

In this work it is important to have the pond absolutely devoid of all fish life before the trout are introduced. The temperature of the ponds during the season when the trout were being reared, ranged from 42 degrees to 72 degrees F.

RAISING BROOK TROUT TO FINGERLING STAGE IN BASS POND

The raising of brook trout to fingerling size in a bass pond was undertaken in the season of 1926, Pond No. 22, which is 100 by 130 feet and 4½ feet deep at the draw-off, being selected for the purpose. About 10,000 brook trout from the hatchery were released in the pond on April 16, after it had been thoroughly cleaned and fertilized by using one-half load of horse manure and about fifty pounds of clam meal. Nothing further was done until 37 days later, when a number of trout were seined up and found to be 1½ inches in length and in fine condition. Again, 30 days later, another lot was seined up and found to be 2 inches in length and still in excellent condition. Still another lot was seined up 30 days later which averaged a little over 3 inches in length. They were not disturbed again until September 30, when all were taken from the pond and averaged from 4 to 6 inches.

In the earlier part of the work, the trout were fed three or four times a day on clam meal, later on the feeding was cut down to twice a day, and after the first 30 days they were fed once a day. Examination of the fish from time to time under a microscope confirmed expectations that they were taking plenty of clam meal. The actual number removed from the pond was 5,000 of which part were distributed in public waters and the others were sent to the trout hatchery at Harietta, Michigan. No dead fish were found at this time, and it is thought the losses were all due to kingfishers and other water birds.

The temperature of the pond was taken once a day during the noon hour, the low being 46 degrees and the high 75 degrees F. The pond had a generous supply of vegetation most of the time and the fish seemed to be feeding rather low in the pond until the last 30 days, when they came to the surface for part of their food. They were highly colored and were in very healthy condition.

SOME OBSERVATIONS ON THE PRODUCTION OF LARGE-MOUTHED BLACK BASS AT SAN MARCOS, TEXAS, FISHERIES STATION

By O. N. Baldwin

The most important of our fresh water fishes in Texas is the large-mouthed black bass, the king of inland waters. I here offer some observations on the reproduction of the large-mouthed black bass in the ponds of the U. S. Fisheries Station, San Marcos, Texas, during the past season. Having been away from San Marcos Station for nearly 20 years I wanted to know something about the number of fingerlings the individual ponds were producing. So far as I could learn the former Superintendent had kept no record of the output of any individual pond but only of the whole output regardless of the individual ponds from which the fish came.

We stocked our ponds by using the best fish on hand from the previous year and by collecting others from streams and lakes and using what we considered the best for our purposes. Right here I want to say that, in this day and time, choice brood large-mouthed black bass are hard to secure in sufficient numbers. Many of our adults were rather small and inferior to what they were here 25 or 30 years ago, when we could in a short time secure a number of breeders within a few steps from our ponds by taking them with a seine from the San Marcos River. But times have changed, and now the six to ten pounders are few and far between. In fact the largest brood fish we have now will not tip the scales above five pounds and many fall below two pounds.

With the best brood stock available we placed something over 40 to the acre of water except in one pond, our largest. Into this we put some young stock expecting it to grow into something by the next year. I give below details of the output of eight ponds all constructed in the same kind of black land soil, with the same water supply, vegetation and natural food. The fish in all the ponds were fed regularly with live minnows. In placing the adult fish in the ponds we tried to get a few more females than males. But I want to tell you that the man who can handle adult large-mouthed black bass well along before spawning time and

always separate the males from the females correctly is an artist. And right here is where a very important feature of the game comes in.

The ponds, area, number of brood fish, and fingerlings produced follow:

Pond No. 1,	.67 of an acre,	30 adults,	produced fingerlings	4,150
Pond No. 2,	.67 of an acre,	30 adults,	produced fingerlings	2,465
Pond No. 3,	.67 of an acre,	30 adults,	produced fingerlings	12,030
Pond No. 4,	.67 of an acre,	30 adults,	produced fingerlings	38,250
Pond No. 5,	.58 of an acre,	30 adults,	produced fingerlings	59,940
Pond No. 6,	.79 of an acre,	40 adults,	produced fingerlings	23,029
Pond No. 7,	.21 of an acre,	20 adults,	produced fingerlings	23,625
Pond A,	1.10 acres,	100 adults,	produced fingerlings	79,230
Totals,	5.36 acres,	310 adults,	fingerlings	242,719

Number of fingerlings per acre, 45,287
Number of fingerlings per pair of adults, 1,567

On April 23 just when there were a number of fine schools to be seen in Pond No. 6, a heavy rain storm caused the flood water from the city to break over and flood the pond from upper end to the lower end. The water passed over the bank right near where several schools of fry had been seen shortly before. They were not seen after the flood, therefore, I am confident that the production of Pond No. 6 was curtailed fully one-half.

Ponds No. 1, No. 2 and No. 3 proved almost a complete failure, especially Ponds No. 1 and No. 2.

I have been unable to determine just why these ponds should fall so far below Pond No. 4, for, as stated before these four ponds are the same in every respect as to construction, water supply, vegetation, food, etc.

The vegetation in all these ponds is very dense and contains an abundance of aquatic insects fully as large as the numerous insects for which Kansas is noted and that means some.

Pond No. 7, our Baby Pond, gave us 23,625 from one-fifth of an acre. Why can we not make ponds three times the size of No. 7 produce fingerlings in proportion?

The demand for fingerling black bass has increased to such an extent that to keep pace with the demand we must find a way to raise two fingerling large-mouthed black bass to one raised last year. Can we do it? We are going to make the effort, so Brother Fish Culturists aid us with your experience and kindly advice.

A few words in reference to the feeding of our adult fish. The large-mouthed black bass love a clean bite and for years and years nice live minnows have been the choice, but we are changing that, as it is not only a very bad policy but very expensive. It formerly took three men and a truck two days or more out of every week to collect sufficient to feed our brood stock and you know what the cost would amount to in a year.

Now we feed about 30 pounds of fresh beef hearts and that costs $3.00 a week and the time of one man for about 2½ hours three times a week. We are now feeding 400 adults three times a week on beef hearts and nearly all are taking it freely and the fish are as healthy and fine as any we ever fed on live food.

We are also feeding finer beef heart to the fingerling bass No. 3 to No. 7, and they are learning to take the hearts very nicely, but the man feeding must have patience while feeding and see that all have a fair chance to partake of the diet.

BLACK BASS—WHY?

By J. P. Snyder

Cape Vincent, N. Y.

All along the St. Lawrence, the Susquehanna and hundreds of other rivers and myriads of streams; by thousands of camp fires around the Great Lakes, Finger Lakes, Champlain and unnumbered other lakes and ponds from the Rockies to Maine; from beyond Uncle Sam's northern portals to the Gulf; one great gripping theme comes up again and again. One theme that, from youth to old old age, makes more boys and men in whom red blood flows—sit up and take notice than does politics in an off year or bootlegging in any season. And this is not a new theme; it was not even new when this organization was born. It is a theme that never grows old nor stale, paradoxical as that may seem. It grips the old, the young, the rich and the poor. It casts its spell over hovel and palace and it grips all along the way of life. It is one of those things that lives and not even the heat of a Kansas summer, nor the bite and sting of a New England winter can kill. It lives and never shall die, nor grow old, nor stale as long as men are men and boys are boys. A theme that steals away time, soothes jaded nerves, and rests the weary. And what is this theme; this theme that old, old men like to recall; and of which boys dream? It is none other than that magic word BLACK BASS.

Our lost loved friend and companion, Doctor Henshall, was right when he crowned him King of the Finny Tribe. And why did he crown him king? Why does the boy with willow pole and cotton line dream of him? Why do men in all conditions of life and all ages lay aside the press of business, the responsibilities of office, and even millions forsake home and fireside for a time at least, to wade in mud or choke with dust, to swelter in crowded hotels, or sleep on hard boards in shoreland shacks, to dream and work and save for days and days that one day may be spent in quest of him? Are there no others of the Finny Tribe? What of speckled beauties that flip and glint in mountain streams; what of salmon, silvery flashes that leap and dart, and bulldog muskies and a host of others that tug and plunge and pull? Worthy contestants all; they have their devotees: but, "pound for pound": yes, Henshall was right.

He crowned him King for the very reason that men spend millions to see Dempsey fight. He crowned him King because blood red flows in his veins; he fights; he has the will to live, to see it through to the very end. That is why he crowned him King and King he is.

And what of this King? What is it men are saying along river and lake and stream? One of the things we hear everywhere is the question "Why?" Why did they bite to-day? Why did that big one take that plug? Why were they so abundant here and there and everywhere and why are there so few to-day? And so again and again we hear the question "Why". And men and men and boys and boys ponder over and over and revolve again and again that question "Why". And he, he who would write his name in letters big in the hearts of a million men to-day, this day is he who will answer this question "Why". But the answer will not come in a day and a day but it will come, must come some other way, little by little even as grains of sand come to lie on the shores of the sea. What if it, in its fullness, does not come to-day? And what, if it could come in a day and a day, would we want it to come that way, would we have it come that way? What of the dream the quest, the search in the hearts of a million men to-day? It is in the quest, the search, the dream and not in the tug of the line alone that pleasure comes. So let us continue the search, the quest, the dream and ask the question "Why"; and each in his place, his turn to bring his grain of sand to the shore of the Black Bass Sea. And this sand, each grain should be welcomed, treasured no matter from whence it comes. It is only in the hope of pointing the way to a grain of sand that the following is given here. Some time, somewhere black bass came to be in the Monocacy River, near the Mason and Dixon Line, but their way to streams that made this river was blocked by dams they could not scale. Here because of a horde of minnows, suckers, stone cat, and a flood of what-not of smaller animate forms (and in this what-not lay the great secret, the answer to the question "Why"), they multiplied and waxed fat, and far and near boys and men came with cart and team and for some years took them in numbers large, for there was no end of them. Nor did an end appear until that horde of minnows, suckers, stone cat and that flood of smaller animate forms, that what-not, went the way that all good bait should go. Then they became

less and less but, when the writer was a boy somebody put some of them above the dams where still there lived a host of tiny members of the Finny Tribe and a flood of smaller aquatic things. Here, too, they multiplied and grew and grew and spread farther and farther towards the headwaters of Marsh Creek, Rock Creek, Toms Creek, and Friend's Creek until in every pool and hole in a combined stretch of fifty miles were many, many spiney rays, in fact there seemed no end of them and men and boys from far and near took strings and strings and bags and bags of them and still they grew and multiplied until, alas here too, the flood of minnows and other aquatic things went the way the boy on shady bank with willow pole and cotton line hopes and dreams the bait on his hook will go. Then they dwindled and dwindled until to-day but one is found where yesterday a dozen lurked and played.

Now he who with keen eye and microscope would truly note the change from that yesterday until to-day will have in large measure answered one of the questions "Why". And he who, building on the answer to this question, shall bring these waters teeming with minnows and this flood of what-not back to their yesterday will have placed his name in undying fame, for he will have shown the way to fill our lakes and streams with that King of the Finny Tribe again. Here, more than in any other place must be found the way to the answer to the question why there are so few bass to-day where yesterday they teemed. Here only those trained to observe and to dig deep may enter far and it beckons them and is worthy their greatest endeavor; for does not a call this day, each day, from more than a million men go forth to them. And so the question "Why" goes on and on and yet all the while from you and Guy and Si by northern lakes and southern marsh or eastern stream or western pool comes a little sand, a little light, on the way to the shore of the Black Bass Sea.

Discussion.

MR. I. T. QUINN (Alabama): Mr. President, here in Alabama we are not particularly interested in the small-mouthed bass, although we have a good many of them in the northern part of the State, in our colder streams; and occasionally you find them extending far down into the southern part of the State. The large-mouthed bass is the great game fish of Alabama. Up to this year Alabama had never

undertaken the propagation of fish. Our hatchery ponds are not all completed; we are continually adding to them as funds become available for the purpose. We are propagating bluegill, bream and the large-mouthed bass.

I was interested in the first paper that was read on production of the large-mouthed bass. We have one two-acre pond at the Alabama hatchery stocked with 305 brood fish. In the spring we removed from that pond and planted approximately 43,000 No. 2's. We have on hand now from the pond perhaps a little above 5,000 No. 1's for planting which will be done during the month of October. As I have said, this is our first experience in fish propagation. We took our brood stock from a lake owned by the Alabama Power Company, a shallow lake of about seventeen acres which is about sixteen miles away from the hatchery. We find that these fish are all pretty well domesticated because they have been reared there for years, so we have had practically no trouble with the brood stock from the very beginning; they are entirely different from the ordinary wild bass that you get from the streams over the State. They take food much more readily and therefore get off to a much better start. We in Alabama and throughout the south are especially interested in the large-mouthed bass and its propagation, and I hope that this discussion will go into the matter very thoroughly.

MR. GEORGE N. MANNFELD (Indiana): In Mr. Baldwin's paper mention was made of the breeders being smaller, and of the fact that there are very few large fish such as those of nine pounds. In our northern waters we rarely catch a large-mouthed bass that grows that large. We have instances of large-mouths being caught at seven pounds, and there was one report of a bass weighing eight pounds and thirteen ounces being caught in Indiana waters. Now, we all know that the bass will not be the same size even though they are the same age; in other words, a bass five years old may be a certain length and weight and one that is far smaller may be older. Food and environment have a good deal to do with the size of the bass. In our hatcheries in Indiana our bass breeders run about three to three and a half pounds. Our experience has been that the really large bass, being older, do not produce as well as the smaller ones. In fact in our small-mouthed bass breeding we find that the choicest breeders run about two to two and a half pounds.

I am particularly interested in knowing whether anyone here has observed the difference between varying sizes of fish as to the production: Whether a nine pound female bass spawns properly as compared with one that is smaller, say four or five pounds in southern waters. In southern areas, of course, the fish feed throughout the year, whereas in northern waters they do not, and that accounts for

the fact that they do not grow so large. But I would like to know whether these nine pound females produce a nest of fry annually, and whether they produce more fry than the others.

MR. QUINN: I am sorry that we have no information from Alabama, because when we take our brood stock we put back into the waters all bass weighing more than three and a half pounds—that is by guess weight, of course. We take our brood stock averaging from one and a half to three or a little above three pounds, so that we are not able to give any data at present, and perhaps will not be, because we are of the opinion that the larger fishes will not produce as heavily as the smaller ones.

MR. TITCOMB: These papers on the production in ponds are very valuable; the more we can get of them the better. But conditions vary so much as between the north and the south, as Mr. Mannfeld has pointed out, that when the fish culturist reads these tables at home he will naturally take the tables of production from the southern hatcheries if his waters are in the south or from the northern hatcheries for the purpose of comparison with waters in the north.

Mr. Mannfeld refers to the size of the bass at San Marcos. Some years ago it was reported from the San Marcos station that a large-mouth bass attained a weight of eleven pounds in three years. These nine pound fish that he speaks of may be only a couple of years old, just about the age that two pound bass would be in the north. As to the number of eggs a bass of given size will produce, so far as our figures go in the north, one of Dr. Emmeline Moore's papers, stated that she had counted the number of eggs in a four pound small-mouthed black bass, and found it to be 25,000. One dislikes to cut open a bass to count the egg production. The more practical way would seem to be to get tables of production, from year to year, in the north and in the south, in reference to the two species. The more of them we get the more valuable they will be for the purposes of comparison.

Mr. Lydell spoke about the importance of having the bass go to winter quarters in prime condition. That is very essential with all species. We do not want our trout to be too fat before they spawn, but you cannot get the bass into too prime condition in that respect; nature takes care of it before they are ready to spawn in the spring.

JUDGE MILES: Did you say that this four pound female small-mouthed bass contained 25,000 eggs?

MR. TITCOMB: Yes, and I think that is more than they ordinarily have credited to a bass of that size. We generally, I think, are in agreement that with the trout all production is based upon the weight of the fish rather than upon the age. I presume it is the same with the bass.

JUDGE MILES: With reference to the first paper read, I presume that

after the bass nested the adult fishes were removed. What is the most practicable method of taking these adult fish out of the rearing ponds?

MR. TITCOMB: So far as I have had anything to do with it, we have not removed the old fish. It is not the old ones that eat the little ones, as a rule; it is the little ones that eat each other.

MR. MEREDITH: I put fifteen pairs of breeders into one pond, and in my case the old ones did the eating, because there was not enough difference in the sizes of the fingerlings for them to eat each other. We remove our adult fish—we left them in there this year just as an experiment. We take them out with a barbless hook; two or three of us go out and catch them in a couple of days. We rarely lose a brood fish.

MR. TITCOMB: I would not mind working for you during that period that you catch them out with the barbless hook.

MR. LECOMPTE: Do you not remove the brooders from one pond to another?

MR. TITCOMB: I am talking of practices that have come under my supervision. In some places they do remove the breeders, but in one of these papers reference is had to the production of fish in ponds where the breeders were retained as compared with the ponds where they had removed the fry to ponds that contained no large fish.

MR. LECOMPTE: How do you refertilize your ponds?

MR. TITCOMB: You mean in the fall?

MR. LECOMPTE: Yes, unless you remove your brooders.

MR. TITCOMB: When you finally draw your ponds and clean them out you remove your brood stock also.

MR. LECOMPTE: You do it at the same time?

MR. TITCOMB: Oh yes, but during the summer while the fish are growing it is not necessary.

MR. LECOMPTE: It is the small fish that eat the small fish, not the brood fish that eat the small ones—that is our experience. That is, the three-inch fish will eat the two, and the two will eat the one.

MR. TITCOMB: May I ask Mr. Meredith what is the area of the pond that he referred to?

MR. MEREDITH: About 125 by 80, I guess.

MR. TITCOMB: About a quarter of an acre?

MR. MEREDITH: Yes. Did I understand from those two papers that were read that the brood fish were all left in the ponds?

MR. TITCOMB: It is a practice to remove a portion of the fry from the nests to other rearing ponds and to leave a large number of the young in with the breeders. If the breeders have sufficient nourishment they do not want the little stuff like the small bass. As the infant bass grow larger they take care of themselves and seek refuge

in the vegetation; they keep away from the big fellows, but they do not keep away from each other.

Now, with fifteen pairs of breeders in your pond you probably found that there would be a period of fifteen days between the spawning of the first pair and the spawning of the last?

MR. MEREDITH: Yes, that is true.

MR. TITCOMB: And the progeny of the pair that spawned first would be competent to gobble up all the pairs that were bred a few days later. Are these large-mouthed bass?

MR. MEREDITH: Yes.

MR. TITCOMB: Well, they are worse than the small-mouthed.

MR. MEREDITH: We could follow up a school of these brood fish, weighing a pound to a pound and a half, and clean up the school in two or three hours.

MR. TITCOMB: You mean a school of young bass?

MR. MEREDITH: Yes. I have watched them do it time and again.

MR. TITCOMB: You are not properly training your parent fish.

MR. MEREDITH: Well, a pound to a pound and a half is as small as we put in, you know—what we have left over from sorting our other fish up.

MR. TITCOMB: If you read the bass papers of 1924 and 1925, including Lydell's original paper, you will find that the fish culturists who have been engaged in pond culture for a number of years generally agree that decimation of the young does not come from the parent fish, but that they do devour each other.

MR. MEREDITH: Oh, surely; I know that. We catch them with the tail sticking out of the mouth, digesting them as they swallow.

MR. TITCOMB: They reduce their own number about sixty per cent in sixty days in many places.

The more we talk on the bass the more we hark back to a lot of material we have been over in previous years. Mr. Snyder referred to the changing conditions and the lack of food, if I gathered correctly from his paper. In the north and in the New England States, where the bass have rather cold water, we are up against a very serious proposition. It has been stated in these meetings, and it is generally acknowledged, that bass require more cubical content of water per fish than any other species. With us the bait fishermen, the men who are catching minnows for sale and the sportsmen who catch minnows for their own use, are very wasteful. They do not realize that there is a limit even to the production of minnows, and the result is that some of our waters are becoming depleted of the natural food of the bass. I have in my recent observations come to the conclusion that it is useless for us to put more bass into many lakes where they are crying for them; what we need in those waters is minnows. It is about the only natural food that we can introduce. But the bass have

completely cleaned out the minnows in many of them. This summer I visited a lake in the Adirondacks, back from Ticonderoga, N. Y., a beautiful, natural, clear water lake, teeming with small-mouthed bass. I was informed that they never got any bass over ten inches long. Around the shores there were fallen trees with their branches submerged, making a splendid cover and protection for minnows. I went around the shores of the lake during still water; I could see down six feet and a good distance each way, but I did not see a minnow on the entire trip. The next morning I looked more particularly for spawning beds. On the bottom of the lake, in from four to six feet of water there were areas the length of this room where the beds were in very close proximity, and apparently only recently deserted. With a trout rod and flies I caught twenty-one small-mouthed bass, ranging in length from seven to ten inches; the largest one I took was ten inches. I killed thirteen of them for examination. They were in very fair condition—not thick, but good clean fish. The intestines were free from parasites; there was nothing to indicate that there was anything wrong with them except that seven of them contained spawn in a state of disintegration; part of the eggs were white. Here is a case where the bass, as I theorize, have become a stunted race for lack of food. In the previous year, according to the records of the club, only two bass were taken which weighed a pound; one of them weighed three pounds. We had a very late, cold spring, and my first theory was that these bass had received an impulse to spawn on account of a sudden rise in the temperature, and that a sudden drop in temperature before they had performed the act had caused them to be egg-bound. The emphasis which has been laid upon the importance of having the bass in the pink of condition when they go into winter quarters and the talk I had with Mr. Foster on the subject has led me to conclude that it was lack of food that caused these fish to hold their spawn until they were egg-bound. The intestines of these fish, including the eggs, were submitted to Dr. Moore who found nothing wrong with them.

MR. REEVES: I am new in this work of the conservation of fish, and I would like a little information. As Mr. Titcomb has pointed out, the supply of minnows in our State has been almost entirely depleted. I would like to ask some of the members from the southern states if the bass will eat Gambuzia minnows. I sent to the United States hatchery at San Marcos, Texas, to get my brood stock of the Gambuzias, and if it is practicable I want to establish them in all our four hatcheries, as well as in the miniature fish hatcheries that the Izaak Walton League have established in our State. On 33 of our lakes the Izaak Walton League have established fish hatcheries, the water area in these cases being from one acre to four or five. They distribute fish

from the hatcheries. I sent a fish culturist to help them collect their brooders, and they distribute their fingerlings. The hatchery at Tahlequah reported to me that they had delivered 10,000 four inch fingerlings out of an acre of water. The first one of these hatcheries set up in the state of Oklahoma was in the little town of Atoka. The Izaak Walton League built a small dam there below the city water dam, covering about three acres, and the cost to them was $25. They put 42 brooders in this water and after they had all spawned they took them out with barbless hooks and put them back in the main lake from which they got them. They asked me last fall if I would plant the fish for them in the streams of that county. I sent two men from the hatchery and we deposited between 30,000 and 40,000 four inch bass there and that led to the establishment of these 33 miniature hatcheries. I would like the southern men to tell me whether the Gambuzia minnows would make fish food.

MR. VIOSCA: Gambuzia minnows make excellent bass food, but like the human, bass prefer those things which are the hardest to get. The marshes of Louisiana and the streams which traverse them are the natural homes of myriads of Gambuzia minnows, and in the years following drought periods, when the Gambuzia minnows suffer, we have a development of these mosquito plagues. One of the reasons for that is the absence of Gambuzia minnows and their associates and the abundance of mosquito food. Following our drought periods during the past decade we have always had exceptionally wet years, and this year is one of that character. On account of the abundance of mosquito larvae, the presence of crustaceae, and the absence of bass and other game fish from our swamps, the Gambuzia become exceptionally abundant, and as the reverse weather condition prevails the bass and other game fish are found in unusually large numbers. Our mosquito cycle, as with the Gambuzia cycle, runs, therefore, in three year periods, and so with our black bass cycle. So that the extent of our food supply in the streams determines the abundance or otherwise of the bass in those waters.

MR. REEVES: Does a considerable lowering of the temperature of the water affect the Gambuzia minnows? The reason I ask the question is that two years ago, when on one occasion we had a sudden frost, the Gambuzia minnows seemed to disappear. The ones I brought in this year have given us a wonderful hatch.

MR. VIOSCA: I can give you the result of an experiment made in a concrete tank in which we placed some Gambuzia minnows. They were subjected to a freeze lasting twenty-four hours, with a quarter of an inch of ice, but they all survived. Our areas do occasionally freeze in Louisiana, but I have never noticed any destruction of Gam-

buzia from that cause. There may, however, be a limit, to the time that the Gambuzia can exist under a sheet of ice.

MR. BERG: In Mr. Lydell's paper reference was made to the difference between the number of bass fingerlings produced in the breeder ponds and the number produced in the hatchery ponds. I think the difference is attributable in some measure to vermin, the dragonfly larvae, beetle larvae, and so on. The bass in the hatchery ponds keep down the numbers of these vermin, and I wonder if feeding the way Mr. Lydell does—every day—has not a tendency in the hatchery ponds to keep down the production. In other words, feeding so heavily in the summer time would have a tendency to make the breeding bass lazy, so that they would not feed on the vermin. What is the experience of some of the men in regard to that? In Indiana we feel that feeding should not be so heavily carried on in the summer time—that is, after the spawning season. You get better results by not feeding quite so much.

MR. DOZE: The point Mr. Berg brings out has considerable merit. We have something like forty to fifty ponds where we raise large-mouthed bass in our hatchery at Pratt. We made the experiment last year of lifting the fry and putting them in a pond where there were no adults. The custom for years at that hatchery has been to leave the brood stock in the ponds and not to molest them until it is cool enough to handle them. The production of fingerlings was not increased by this method. In fact, the particular pond we used produced more fish the year before when we left the adult bass in there than they did last year, when they were not in there at all. Now that excited my curiosity and this year we enlisted the assistance of the Biological Department of the Kansas Agricultural College, of which Dr. Robert K. Nabours is the head. Dr. Mina Jewell, who is to the West a good deal like Dr. Emmeline Moore is to the East in fish matters, is in charge of the investigations of our Department, and it is her practice to employ students who are working for a degree to do the field work, at a nominal cost to the Department. It was shown that the dragonfly wrought havoc in the ponds where there were not fish of sufficient size to keep them down. The dragonfly has an apparatus that he shoots out ahead of his body, like a snapping turtle; he grabs the young fish right in the stomach, and the result is that the fish dies. We have had large numbers of fry killed by the larvae of the dragonfly, which, as you know, attains a considerable size in our country. The dragonfly may be classed among the vermin of the ponds, and he certainly wreaks havoc among the fry when there is nothing to protect them. The crawfish also become a pest, particularly when we do not have the adults to keep them down. The crawfish do not hurt the fish when the water is at its normal height, but when we pull the pond

the crawfish get into the ditches and down to the distributer in the drain where we catch our young fish, and if we are not careful, their attacks result in the loss of a lot of fish. To overcome that we plant what we call the freshwater sheepshead, or drum. We plant these fish, when they are probably a foot long, in our bass ponds to keep down the crawfish. These drum get to be enormously fat, and they are wonderfully big fish when we take them out in the fall. Our chief trouble at this time is relative to distribution. It is necessary to hold over some of our fish through the winter, and that causes an extraordinarily large loss. There is also some irregularity in our breeding time. It may be of interest to you to know that at the latter part of July I saw fry coming off the nests, fully forty-five days late. That is a very peculiar thing; I do not understand what caused these particular bass to hold back their spawning time so long.

We also have a good deal of trouble with the pollywog of the bull-frog. When it gets extremely hot and the oxygen content of the water is low, with a small specific gravity, there is danger of infection to our fish and any little scratch causes mortality among the bass. These pollywogs, which we try to keep out of our ponds as much as possible, contribute to a removal of oxygen and a fouling of the water.

The question of bass culture in Kansas is largely a matter of keeping the advanced size bass out of the ponds. We have even resorted to netting. Eugene Catte, whom many of you know, who is an old hand at the bass business, says he has seen these large-mouthed bass six inches long about the first of August. Now you know what a bass of that size is going to do in a pond with smaller fish; he just goes around and gorges himself. If we had some method of sorting our different schools of bass, and keeping them sorted, it would be a wonderful help to us. But during July and August it is folly for us to pull down the ponds or molest them in any way, because of the extreme heat in the middle of the day. Of course it is cool at night.

We are also troubled with herons, bitterns, and birds of prey that are protected. It is my opinion, and it is the opinion of everyone who has been out there at the hatchery, that we ought to shoot every heron and bittern and kingfisher that comes on the place. And we do do it, but you know their range is large and it is almost impossible to keep them down. A friend of mine observed one of these little blue herons make thirteen stabs and hit a bullseye eleven times. We shot one of these bitterns, and we found seven bass in that fellow's neck. It may also interest you to know that ducks learn bad habits. I shot a gadwall duck that was in a pond we were drawing down, and we found bass in him. We always considered the gadwall more of a grain eating and tender root eating duck, but there was a case of a gadwall eating fish. We are not bothered by the mallards, but we

consider practically all ducks that come there as somewhat of a menace. They do learn to eat fish although they probably would not do it if they had other food.

MR. BERG: What feeding of adults do you carry on in the ponds in which you find the tadpoles plentiful?

MR. DOZE: We depend largely on food we raise in the ponds. We feed meats occasionally, but only very little. We tried, with some success, a system of electric lighting to attract the green bugs, but that is more for the younger fish. Goldfish are still planted for the larger bass at the Pratt hatchery, although the goldfish seem to grow rapidly. We do feed them, however, to the old bass. We do not feed artificially; we believe it is dangerous where the water gets up to 100 degrees in the day time.

MR. TULIAN: Is that the freshwater sheepshead you referred to—the gaspergou, as we call them in Louisiana?

MR. DOZE: Yes.

MR. TITCOMB: When you except the mallards, do you except both the black and the green mallard?

MR. DOZE: We have practically no black mallards—just a few. I do not think there has ever been a black duck shot on the hatchery.

MR. REEVES: What system do you employ to keep down the pollywogs and the bullfrogs?

MR. DOZE: There are now 114 ponds at the Kansas hatchery, and it is some job to keep the bullfrogs out of the place. It is also some job to keep the turtles out. We have a meandering shore line on which we do not cut the grass, because it attracts insect life. That, I may say, is one of the best things we have ever done; our fish show the results of the additional food they get because the grass is down on the edge of the water. I invite a few of the folks around who enjoy bullfrog shooting to come in and do it, but they must go with someone from the hatchery. From the first voice in the spring until the winter we are always carrying frogs to the house and giving them away; we make continuous war upon them. But even with all that war, they get in, and how they do it is a mystery to us. We have one or two places where we do not shoot them, because I like to hear them sing.

MR. PETTIS: Did you ever try to pick up the frog spawn?

MR. DOZE: We do that, but a lot of it gets away from us even then. We have a man who watches the screens and examines them every day. He carries with him a long net on a twelve foot handle. Frequently he gets to a place where he cannot reach the spawn, and then he will forget about it, and then when he comes back with his high waders, they are hatched and gone.

JUDGE MILES: Did you ever try the introduction of moccasins?

MR. DOZE: We kill snakes; we make war on all these things, but it seems that the more war you make the more you have to make. There was another experiment we carried out: Mr. Phil Zimmerman pointed out that he had read in the Saturday Evening Post where Dr. Woods Hutchinson commented on the value of iodine content in the blood and the fact that those persons who had the proper quantity of iodine were healthier and probably grew a little faster than the others. So we tried that out on our fish. We are lacking in iodine in our water, and the fish did respond to the experiment remarkably well. We tried it on our large-mouthed and small-mouthed bass—with apologies to Mr. Foster, who does not think that is a small-mouth bass.

MR. TITCOMB: How did you administer it?

MR. DOZE: Put it right into the water. We tried it on our spotted channel catfish, and they responded to it right away, whereas those that were not treated did not show the same rate of growth. We kept a note of the results of this experiment over a period of sixty days, and since then we have been putting a little iodine in the waters. As you know, we have a lot of salt in that country; they are making now what they call an iodine salt, and we use that in our ponds at times. I think the use of iodine is a good thing in inland waters where the iodine content is not sufficient. The crappie do not respond, because they do not need so much iodine. The crappie's blood does not contain as much iodine as that of the other fishes.

MR. TITCOMB: In what way does the effect of lack of iodine upon the fish become evident?

MR. DOZE: I think it weakens them; they do not grow so rapidly, and they are sometimes off color.

MR. SURBER: The discussion of the bass question, of course, has occupied a good portion of the time of every meeting of the Fisheries Society that I have ever attended. With the consent of those present here I would like to revert to what is probably ancient history, as well as make comments on some of the effects which have recently been observed.

Back as far as 1905, when Mr. Titcomb was the assistant in charge of the Division of Fish Culture, it was his habit to instil into the fish culturists under him—and that has special reference to myself, being then a neophyte—the desirability of carrying on a great many experiments, particularly with reference to bass. I was stationed for five years at the government hatchery at White Sulpher Springs, where we had under consideration the propagation of both the large-mouthed and the small-mouthed bass. I am very sorry that the records that we made during that period from 1905 to 1909 are not available at this time, because undoubtedly we could obtain much valuable information on that particular phase of fish culture in that territory. I think

we all realize that conditions vary so in different parts of the country that no hard and fast rules can be adopted; we must consider all these matters in relation to the conditions that prevail in the various sections concerned.

It has been our experience in Minnesota that where we removed the adult fishes from the ponds and left the fry to the mercy of the numerous enemies found in those ponds, such as the water scorpion and the larvae of various other aquatic insects, we got less satisfactory results than we did in those ponds in which we left the parent fish undisturbed. This has been corroborated in recent years in our state. It is my belief, based on experiments which we have conducted, and verified over a period of eighteen or twenty years, that the whole question of bass culture rests in the proper food for the fry. We can forget very largely the food conditions for those fish which have reached the fingerling stage, because they can subsist and maintain life not only on aquatic insects and their larvae but on land insects as well. In ponds which are fed by spring water my experience has been that it is a case of preparing your ponds well in advance of the spawning season—a year before, if possible—by the introduction of aquatic plants and the preparation of the bottom, as well as the introduction of Entomostraca, the natural food of all young fishes. If we have a dearth of Entomostraca and other semi-microscopic food on which nearly all young fishes, particularly the young bass, subsist and grow, we are bound to expect negligible results. So that where such life is deficient we attempt to introduce that kind of food into our ponds.

With reference to the cannibalistic properties of the bass, whether large or small-mouthed, I recall very distinctly that this year at the White Sulphur Springs hatchery in particular we were in the habit of gathering our fry, both large-mouthed and small-mouthed, into a large tank just previous to shipment. If we were not extremely careful to get these fry out within twenty-four hours, the loss would be enormous. On one occasion we were unable on account of weather conditions to get the fry out for two or three days, and when we went to make the shipment we had practically nothing left. All those fry were of the same size. Size does not mean a thing to me so far as keeping down cannibalism is concerned. I think we see that best exemplified in the wall-eyed pike. When wall-eyed pike are delayed in emerging from the egg they come out with the food sac practically absorbed, and hungry as little fiends. They immediately begin eating each other, and it is not an uncommon thing to see two or three, even four, linked together. These are perfectly healthy fish and they must be fed at that season, otherwise your loss is bound to be tremendous. So it is wholly a question of food for your fry; if that is not provided you need not expect results.

MR. MEREDITH: Do you feed the brood fish anything?

MR. SURBER: Yes, that is a very important matter. It has been recognized by everybody that it is absolutely necessary to give them proper feed. If they have proper food in sufficient quantity they will not, in my belief, prey on the young. The superintendent of this same hatchery and myself on a number of different occasions experimented along that line with the bass just prior to the breaking up of the schools. As I recall it now, they were the large-mouthed, at least two or three schools of them in one of our largest ponds, and they were then about an inch and a half in length. We secured a number of creek minnows, mostly shiners, from a creek near the hatchery grounds, and carrying them out in a bucket we would throw a few minnows in at a time for these bass to feed on. There were some bass that were guarding these schools. A few of the schools had not broken up, and we were willing to sacrifice a couple of these bass to determine, when the minnows were thrown carelessly into the school, what percentage of the young bass they would take in their efforts to get the minnows. When we threw the minnows in the motions were so rapid that we could not be absolutely certain on this score. But when we got through feeding, Mr. Robinson, the superintendent, caught two of the bass with a fly rod; we killed them and cut them open and found the minnows, but no indication that any of the young bass had been taken. We did not care to sacrifice any more fish, but we felt from that experiment that it was probably safe for a careless fish culturist to feed minnows to the bass in the vicinity of bass fingerlings. We were always very careful to keep our bass properly fed before we wintered them. When we removed the fingerlings for shipment we removed them all to one pond and wintered them there, and then introduced them very early in the spring, well in advance of the spawning season, or about as soon as we could determine the sexes. While I think we got fair results, they were never satisfactory, because in my belief we had at that station but one pond large enough for the best results, and that was a pond, as I recall it now, of approximately two acres or a little more—about the size of our largest pond.

MR. DOZE: At what age do these fry, in your experience, begin to prey on each other when placed in such conditions as you describe?

MR. SURBER: We remove most of our bass with the Fuller trap screen when we want to transfer the fry to another pond. The frame is of galvanized band iron, covered with bronze wire cloth. There is at the bottom of the frame a funnel made of cheesecloth, and as soon as we find the fry showing indications of rising from the nest this screen is placed over the top of the nest and when they swim up we lift them out into a tub of sufficient size to allow the trap screen to be set into it. The funnel is then released so that it drops to the bottom and the

fry are all washed free of the funnel and into the tub. I would say that on an average these bass were shipped out within forty-eight hours, at the most, from the time they rose from the nests. As we all know, that is just after the absorption of the sac; I have never known any fish to swim up until the food sac was practically absorbed.

Cannibalism among any of our game fishes will start very quickly if they do not get proper food. It is wholly a question of supplying our fish with food at the proper time, and unless they have it we may expect cannibalism. In Minnesota at the present time we have certain ponds not properly supplied with food—we cannot get it at the proper season, and we have not yet determined just what should be done But we have determined this fact, that unless we can introduce food in there at the proper time we are not going to have any bass fingerlings to ship. So far as shipping fry is concerned, I would not give a snap of my finger for all you could get into the water; it is the fingerlings that count. And I am inclined to believe it does not always pay to ship fingerlings; I think it is better to introduce adult fish.

MR. MCCANSE: What food do you supply for the bass fry in that state?

MR. SURBER: Entomostraca—that is, Daphnia and Copepods.

MR. MEREDITH: These things disappear in our ponds by the time the fish get almost to the fry stage. The water gets hot, and they do not seem to come any more.

MR. SURBER: I do not know; there must be something wrong to destroy them. I was at the Biological station at Fairport, Iowa, for four years prior to my going to Minnesota. At that point the greatest number of Entomostraca appearing in our ponds, or in the river from which we pumped the water to supply the ponds, was during the early summer months when the temperature was around 85 and 90.

MR. MEREDITH: Our ponds at first are black with them, but as soon as the weather gets warm they are gone.

MR. DOZE: That is the condition in Kansas too.

MR. SURBER: There must be some condition there that should be carefully studied by someone competent to do it, because it would look as if there was something wrong. Warm water usually promotes the growth and multiplication of these plankton; it is bound to encourage the growth. We find that to be the case in most of our streams and lakes. Wherever I have been from Arkansas to the Canadian border I have noticed that most of the Entomostraca disappear on the advent of cold weather; it falls down into the bottom of the ponds and probably buries in the mud. I should consider such cases as Mr. Meredith and Mr. Doze have mentioned as worthy of intensive investigation, because there would appear to be something there which cannot be explained. Of course we have many conditions with reference to fish

culture that we have been unable to explain, and that is the purpose of these meetings—to get together and discuss these questions.

MR. MEREDITH: I wrote Mr. Lydell about that and he spent some time at one of our plants. He told me he was using dried clams, dried mussels. I got some this year but I did not have a chance to use them.

MR. SURBER: If I may digress from the subject just a little, I may say that we will shortly publish as an appendix to the report of the Game and Fish Commission of Minnesota a paper on the algal food of certain fresh water fishes, the result of investigations carried on by a graduate student of the University of Minnesota who has been working for our Department for the past eighteen months and who intends to continue her investigations during the winter. The results she has obtained have astonished me in many particulars. She has worked under Miss Tilden, who is recognized, I think, the world over as an authority on algae. Certain species of fish which I had been led to believe were wholly carnivorous—her investigations have had to do solely with young fishes—consume algae in enormous quantities, so I am of the belief that the removal of algae from certain fish cultural waters is a mistake. Examinations of stomach content of the wall-eyed pike, for instance, or white perch have shown a considerable percentage of food of an algal character, embracing various species of algae, while the remainder of the food is wholly Entomostraca. I had determined that fact to my own satisfaction a number of years ago, and it was for that reason that we issued three years ago particular instructions that these fish be planted in deep water but in proximity to an abundant algal supply, and favorable results are already showing from these plants. We did it for the double purpose of planting them where there was a proper supply of food, and of avoiding their natural enemies, as the various species of shiners and minnows would frequent the shallow water at that period of the year. I shall be glad to send copies of this report, when it is published, to all who may be interested. It certainly opened my eyes, and I am sure that all of you who have to do with that phase of fish culture would find it very interesting indeed.

MR. TITCOMB: Have you ever tried tossing pollywogs to the fish?

MR. SURBER: Yes, they will take frog pollywogs, and they will spit out the toad tadpole.

MR. TITCOMB: They will jump at the frog pollywogs as fast as you will throw them to them?

MR. SURBER: Yes, and they will invariably spit out the tadpole of the swamp tree frog and of the toad.

MR. VIOSCA: Some observations I made in Louisiana may be of interest in this connection. The Entomostraca seem to have two cycles, one in the spring and one in the fall, and their numbers are relatively less in the winter than they are in the summer. But in the winter

there is a very low microscopic algal content, such as Desmids, Diatoms and things of that character, whereas in the summer season when the microcrustacea are low in number there is a very high algal content. That may have some connection with it.

MR. SURBER: That has been practically my experience.

MR. VIOSCA: That applies particularly to Louisiana and the lower gulf states.

MR. TITCOMB: I do not know whether Lydell's use of the clam meal, as he calls it, is fully understood. It is used in finely ground form not for the feeding of the bass but as a basis for the introduction of those minute forms of life which feed upon it. In short, it is for the purpose of introducing various species of plankton that he uses this meal.

MR. HAYFORD: In New Jersey we have been working out these problems in connection with the production of the bass since 1916. We have had a great many difficulties that were both discouraging and expensive. Most of them have already been dealt with in previous discussions.

At the end of the season I corresponded with some of the leading bass culturists and found they had as wide a variation in the production of bass per acre each year as I did.

Some of our ponds were giving a production of 25,000 to 50,000 fingerling bass per acre while others gave us only 6,000 to 10,000.

In the spring of 1925 we employed Dr. Geo. C. Embody to make biological examinations of our ponds to ascertain the quantities and varieties of aquatic insects available for bass food. Our examinations proved that a much larger and more certain hatch of young bass could be secured by only slightly fertilizing the breeding ponds.

Therefore, in view of these determinations we placed, in two of these five ponds, during the past three years, thirty-five pair of large-mouthed breeders each. The average production of these two ponds containing a little over one acre each, for the last three years, was over 50,000 fingerlings per pond or 300,000. We now have twelve ponds of this type containing a total area of about fifteen acres.

No doubt a great many of you present will think it is no job to raise large-mouthed bass. I will concede that it is not as difficult to hatch the large-mouthed bass as it is to hatch the small-mouthed. As to rearing from fry to fingerling stage, it is much easier for me to raise the small-mouthed than the large-mouthed for this reason. The large-mouthed bass move in schools and are greater consumers and soon clean up all the small aquatic life.

With the Lydell system you can screen the small-mouthed bass and only leave those of uniform length in the pond. With the large-mouthed it is different. There are a great many schools that often stay out

in the middle of the pond until they are a week old or more. We have found the best way to overcome cannibalism, caused by this uneven growth due to three of four days difference in hatching, is to net all the first and last schools into ponds reserved for this purpose.

I have had a great deal of correspondence with Dwight Lydell and am familiar with his methods. We are both agreed that a reserve supply of daphnia is just as important as the bass fry. While Mr. Lydell can fertilize his ponds to get enormous quantities of daphnia at the time his young fry come on, I cannot under our conditions. By using fertilizer as heavily as he does I do two things, distress the bass to a point of low production and lose a great many eggs on the nests, in addition to getting such a dense growth of green algae along the shores that the young bass cannot get into the shallow water to feed. This low production was at first believed to be caused by retarding the development of the eggs by holding the breeders too long in spring water. This idea was exploded two years ago this spring when we took bass breeders from the wintering pond and divided them up, placing some of them in ponds sufficiently fertilized to insure abundance of daphnia; the others we placed in slightly fertilized ponds. The slightly fertilized ponds produced three times more fry than the heavily fertilized ponds.

In view of the above determinations made by Dr. Embody and myself we have revised our whole system of bass propagation. We remove one-half the fry from the hatching ponds to rearing ponds containing dense clouds of daphnia and heavily stock the breeding ponds with daphnia held in reserve through a supply pipe. Whereas this system sounds complicated and expensive it is not. Two men can produce all the daphnia and do all the feeding of these twelve ponds.

It has taken me a number of years to solve the daphnia problem, for all I visited Lydell at Comstock Park and spent nearly a week with him just as the bass were starting to feed. It is a sight I will never forget as it did not seem possible that a man could hatch and feed so many bass in a pond as he was doing. I visited his plant in early September of that year and I again wondered how he could successfully feed so many fingerlings in his ponds. I spent three days with him learning everything possible. It all looked easy.

As easy as it looked it has taken me three years, with the help Lydell gave me through correspondence, to produce bass and daphnia in satisfactory quantities. There are five important factors to be remembered in the successful production of bass, i. e:

1. Securing and selecting sufficient quantities of breeders of the desired size.

2. Heavily stocking wintering ponds with bait fish so that the bass may reach the spring in a strong, healthy condition.

3. When possible turn spring water into wintering ponds as soon as the water reaches spring temperature. This prevents the bass spawning until the latter part of May or first of June, after all danger of cold snaps is passed.

4. Selecting the breeders as near as possible of uniform size. You should also raise the temperature of the water gradually. Suddenly transferring the bass from 50 degree spring water to 65 or 70 degree lake water is liable to prove disastrous. We have been successful with the small-mouthed each season we have followed this method. We do not ordinarily change the large-mouthed bass from the wintering ponds as they hatch about two weeks later, with us, than the small-mouthed bass. Two tests we have made by holding the large-mouthed in spring water convinced me it was also a good thing to do with them. It gives you about two weeks longer to get your daphnia well started.

5. Only run enough creek water into the ponds to maintain the water level. Any current even though slight, has a tendency to wash most of the daphnia out of the ponds.

I am not going into the methods of fertilizing the ponds as practically every bass culturist is familiar with the production of the common daphnia. Our greatest success in producing food was during the past season. On June 15th in making examinations with the plankton net I found the bass were consuming the daphnia much faster than it was reproducing and if something was not quickly done we would have a very uneven growth and a large loss through cannibalism.

On June 18th Mr. Matsunaga, manager of a large goldfish hatchery, within thirty miles of our plant, visited us. I explained to him the difficulty I was having to get sufficient quantities of daphnia. He suggested that I run down to his hatchery and get a brood stock of the daphnia he brought over from Japan. This daphnia very much resembles the common American form, *Moina macrocopa* but is larger, much more prolific and more easily raised than our American daphnia.

Mr. Matsunaga showed me the complete method of producing this daphnia in concrete ponds built for that purpose. I have his permission to give the same to the American Fisheries Society. Shallow concrete ponds absolutely water tight, 15 to 25 feet square, tapering from a feather edge to 12 to 15 inches in the center or draw-off. He uses 3 to 4 wheel-barrow loads of cow manure. Twenty-four hours afterward he uses one pail full of fish heads, intestines, etc., from the fish market and then stocks the pond with about one handful or one-fourth pint of the daphnia. As soon as the daphnia begins to increase, one pailful of oat-meal porridge should be scattered through the pond. At the end of four days your ponds contain myriads of daphnia. You can then start removing a part of them for the next

three days at which time they have reached their height and it is better to clean out the pond and start over although they continue to reproduce in smaller quantities for some little time. Horse and hog manure can also be used.

We took thirty-six of our concrete trout ponds, 30 feet long, 5 feet wide, 1 to 2 feet deep and used the same method except we used about eight quarts of green bone meal fertilizer to one-half ash can of cow manure. This was thoroughly soaked up with water, spread over ponds and thoroughly mixed into the water with a long handled brush. I also had 200 pounds of sardine meal from the Sea Coast Canning Company of Maine that I used as an experiment in place of the bone meal. The sardine meal caused a greater production. Thick sour milk in the proportion of two pails per pond alone also gave good results. There is no limit to the amount of this daphnia you can produce. It is better to use spring water to set up your ponds with than pond water. By using spring water you get a pure culture of the Japanese daphnia. The large and small-mouthed bass and young bluegills are all very fond of it. On account of the daphnia being larger the bass take it more readily after they attain a little age. This daphnia can be artificially raised in dense quantities from early May right on until September. I am advised by Mr. Matsunaga that it does not do to let this daphnia freeze. In order to insure your coming year's supply it is necessary to propagate sufficient brood stock through the winter in one of the buildings.

By using the above mentioned method of producing food during the past year we were able to raise from 25,000 to 50,000 fingerling bass per acre and 100,000 to 150,000 bluegill fingerlings per acre.

In conclusion will say, in a thickly populated state like our own there is little hope of maintaining bass fishing unless you are able to stock the 250 ponds and lakes with large quantities of fingerlings each year. We were in hopes of being able to sufficiently stock our lakes with breeders netted from the municipal reservoirs. In order to secure these bass they had to be netted when they came in from deep water to spawn. We were of the opinion by stocking with these brood bass we would be able to maintain good fishing in our lakes. It has not worked out as expected. I have made three different tests in the hatchery ponds with breeders netted from these reservoirs and for all the bass were handled as carefully as it was humanly possible to do very few of them reproduced that season. If the same holds true in public lakes, the majority of these bass are caught before they are given time to spawn the second season. I am firmly of the opinion that it would be better to leave the bass breeders in the reservoirs and only remove the fry to especially constructed rearing ponds using the above mentioned method for producing desired quantities of food.

MR. CULLER: The discussion on this bass proposition is of great interest to all of us. I was just wondering if at the Kentucky station and some of the other pond stations, the water supply being from springs, the temperature would naturally be low and that would tend to a deficiency in the amount of the plankton on which the young bass feed.

MR. MEREDITH: It is creek water.

MR. CULLER: You kept the supply running through all the time. I think that is the answer to the question. If you will reduce your water supply so that there will be just enough coming into the pond to make up for the seepage and evaporation, the temperature will get to a higher point and the conditions will be better in the matter of food.

MR. MEREDITH: Too much water.

MR. CULLER: Yes, too much water. It used to be the idea that you had to have a current through your bass pond. We put our supply pipe within ten feet of the outlet pipe so that we can introduce the water and keep up the water level.

MR. TITCOMB: Are you now talking about large or small-mouthed?

MR. CULLER: Large-mouthed.

MR. TITCOMB: Mr. Meredith had in mind the small-mouthed, but I think the suggestion is a good one.

MR. CULLER: I am speaking more particularly for the fellows in the southern localities, because they are working on the large-mouthed bass proposition. We all realize that we can put out a greater number of fish in one stage or the other by having a small pond and stocking it heavily. The bass culturist is working around to the idea of a large pond, anywhere from five to one hundred acres, in fact we have in mind one proposition of a six hundred acre bass pond in which we hope to raise quite a few fish. At the same time we are getting away from the idea of much depth to the ponds. If you have a pond of five acres, five or six feet of depth at the outlet should be sufficient. You then have the area to get the high temperature of water, which tends to a higher production of minute animal life. In one of the large shallow lakes on the reclamation work on the Upper Mississippi River where there are only two or three pairs of bass we have got as high as 14,000 No. 4 fingerling fish. I think that is conclusive evidence.

Mr. Doze had trouble in getting his pollywogs out of the ponds when he was drawing them. If he will use a screen box at his outlet and sink it down into the water with possibly four inches of the sides above, so that it is tight—it may be two feet wide, or four feet, depending on the size of the pond, all of the fish will come out; a man can stand right there, sort the fish as they come up and throw the pollywogs away. We had quite an experience with pollywogs at the Wytheville,

Virginia station, some years ago and we solved it in that way.

MR. TITCOMB: I think his reference was more to the trouble with crawfish when he was drawing the ponds.

MR. CULLER: The same thing applies to crawfish; you can take them right out and separate them. I noticed he said that the nights were cool and that they could not work in the middle of the day. I think if he will start early and just work a couple of hours in his ponds cutting the moss out and then lay off during the middle of the day, he will have a little better success in drawing his ponds.

MR. REEVES: I have one hatchery in which we do not have a fish culturist at this time. It is supplied with fresh water, but I have had a great deal of trouble this summer with an excess amount of confervae and algae. The conferva comes to the top and sours and the acids kill some of the breeders.

MR. TITCOMB: You can easily get rid of that stuff by the use of copper sulphate, administering it as they do in municipal water supplies.

MR. REEVES: It is apt to kill some of your fish, isn't it?

MR. TITCOMB: No, not bass. You can use a weak solution that will not affect the fish but will still get your algae. I think the bass is the most resistant of all the species I have had anything to do with in connection with the use of copper sulphate.

MR. REEVES: I used some copper sulphate, but I was afraid to use too much in case it might kill some of the fish.

MR. TITCOMB: Is that the large-mouthed?

MR. REEVES: No, the small-mouthed in this particular pond.

MR. MEREDITH: I have used about one part to a million with good results.

MR. TITCOMB: Some years ago when this use of copper sulphate was first discovered we administered it in one of the breeding ponds at Washington, at a period when the male bass was protecting the nests. We dragged a bag over the surface, with a line attached and a man at each side of the pond. Professor Marsh, who was then pathologist of the Bureau, made observations as to the effects upon the eggs and the plankton, and found that the copper sulphate did not injure the eggs in that instance, and that there was no injury to the adult fish. It precipitated the algae in twenty-four hours and bred an enormous amount of plankton. No ill effects were noticed.

MR. SURBER: A number of years ago, I think it was 1913—I had been familiar with the use of copper sulphate in trout waters and our bass ponds for years previous to that—I had no hesitation in using it for the destruction of algae in fish cultural ponds. At the Fairport station of the United States Bureau of Fisheries the water supplied for the ponds is pumped direct from the Mississippi River into a large reservoir. This reservoir became so heavily charged with algae that we

had to adopt drastic measures to get rid of it, and as the fish in the ponds below had been determined from former experience to be among the most resistant to the use of copper sulphate, such as bass and sunfish, I gave the reservoir a very strong dose of the copper—as I recall it now about one to one million. The first application was ineffective, on account of the excessive growth of algae, and it became necessary to make a second application, whereupon the desired results were obtained. But I was rather astonished to find that in the course of two or three days, so far as we could determine, it had destroyed all the plankton in the ponds below. Of course in that case we were able to restore the plankton by pumping, because the river water was alive with them, particularly the Entomostraca, so that the food of the young fishes was destroyed for only a short period. The experience I have had since then would lead me to the conclusion that copper sulphate should not be used in ponds where there is brood stock or it is contemplated breeding fry. When the fry have reached the fingerling stage I think it could be done with perfect safety, because it will not destroy the fish if properly used. But I certainly condemn the use of it, from my experience both at that place and elsewhere since then, where you have fry or very young fingerlings.

MR. LAIRD: I would like to ask Mr. Surber what effect copper sulphate has on the heavier plant life?

MR. SURBER: Practically none.

MR. VIOSCA: I would like to ask whether the fish culturists have worked out any method of using shades to control excessive algae in artificial ponds. For instance, in streams where bullfrog tadpoles and things like that abound I use shades such as florists use on their fern beds, and thus cut down the summer sunlight by one-half. Of course I eliminate that shade in the winter.

MR. TITCOMB: I think it is generally understood among fish culturists that if the sources of supply are spring waters, excessive algae can be avoided in areas inhabited by trout. But in this large-mouthed bass work with pond culture a tremendous area of shade would have to be covered. I have often thought of trying such a shade as is used in connection with growing tobacco. The material can be bought after it has been used for tobacco one season at a very reasonable price; it is then sold to the rag man, because it cannot be used a second time for tobacco. Up in our country a great amount of it is used. I do not know whether that netting would have the desired effect upon algae; it is a little heavier and thicker than mosquito netting.

MR. VIOSCA: In some of our small ponds, about 25 by 25 feet, I simply planted a number of willows around the edges, and that seems to produce the desired effect on the whole pond. It shades the shallow waters around the edges and yet does not interfere with the center of the

pond. In another case I simply took poultry netting, carried it to stakes and threw grass and hay on top of it. Two things are accomplished there: One is to keep the sun off and make for coolness, and the other is to prevent the wind from blowing on the surface.

MR. TITCOMB: There are several kinds of algae. I doubt if that could be done in some of our states, having regard to their water supplies.

MR. VIOSCA: I mean the unicellular organisms—Desmids. The problems in Oklahoma seem to correspond more with mine.

MR. REEVES: I do not have any shade on my ponds at all. They cover about two acres.

MR. VIOSCA: Those types of pond correspond more to mine than Mr. Titcomb's, but my problems may be more applicable to his than yours.

MR. TITCOMB: Your native algae are all through the water?

MR. VIOSCA: Yes.

MR. TITCOMB: I thought you had reference to their gathering on the surface.

MR. VIOSCA: They rise to the surface during the day, and during the night they disseminate to the bottom of the water.

MR. MEREDITH: May I ask Mr. Hayford what quantities he uses of the material from which he makes the fish food?

MR. HAYFORD: We use various amounts. The Japanese use probably a pail full. I use dead trout I get out of the plant—perhaps half a pail full, some days perhaps a pail full. On account of the supply of dead trout being rather uncertain I also get sardine meal for the purpose. Take an eight quart pail, thin it into an ash can half full of the manure, fill it up until sloppy, then take the pail and throw it back and forth over the ponds. Then take an ordinary fibre brush on a handle say eight feet long and churn it back and forth and thoroughly mix it.

There is just one thing I was going to say in regard to the cannibalism of fish. I opened up two small-mouthed bass and found seventeen dragonfly larvae in one, but no bass, and thirteen dragonfly larvae in another, and no bass. As to the cannibalistic properties of the large-mouthed, I have seen two schools come together, one around the point each way, say 10,000 in each school, and after they met there were only 10,000—each one walked off with one of his brothers. We made a number of other tests. In one pond we had, as nearly as we could estimate, 25,000 fish, and out of that pond we only got 750, and there were no large fish there to eat them up. Pond No. 6, that I was telling you about, had 80 large-mouthed bass in it, and it is as good a producing pond as we had. So it is quite a problem; I am not in a position to say whether it is good or bad.

As to this question of feeding, Lydell claims that it is a matter of judgment; that you have got to keep watching the material in your

ponds, and if you have a lot of it you do not need to feed so much, but if you have a scarcity you have got to feed more, because the bass is no different from any other animal—he has got to fill his stomach on something once in a while.

MR. CULLER: Do you think it is necessary to have a current for your small-mouthed?

MR. HAYFORD: If the weather is extremely hot, of course you have to put in a little water, but when the temperature stays down at a reasonable point and it is fairly cool, we shut right off tight at nine o'clock practically every night. We only put through enough in the day time to hold the pond level.

MR. CULLER: The idea of the water system is simply to keep up the water level. There is no objection to the water temperature getting high in the small-mouthed ponds?

MR. HAYFORD: Unless as happened in our case this year, we get over pollution of the ponds and then we have to clear them. You can tell by the actions of the bass; they become logy around the sides, and they are not moving about the way they generally do.

MR. CULLER: I have noticed that throughout Minnesota and Wisconsin, lakes which have no current coming into them at all are well stocked with small-mouthed black bass. They depend on their seepage or rain water to keep the water level, and they do well; in fact, it is the native habitat of the small-mouthed. I do not see, therefore, that it is necessary to have a heavy supply or any supply of water coming into your small-mouthed lakes or ponds. I think that is Mr. Meredith's trouble in connection with his food proposition. If I were in his place I would just use enough water to keep up the water level.

MR. HAYFORD: Our river pond is the food supply. We pull from that around into No. 4, which is another river supply pond six feet lower. Then we pull again from that, just feeding in food all the time, but we do not let any of it get out of the last pond; when it gets up to the overflow it is shut off. We find that the minute you put on this current there are large clouds of daphnia hanging right down around your outlet, and we watch that carefully. Another thing about daphnia that is likely to fool you if you do not look out: You can go out there in the morning and see that you have got any amount of it; you go out at noon, when the sun has come out bright, and you have practically none. It drops down, but it will come back again along toward evening. So the time to move the daphnia, or to put your flow on, is either the first thing in the morning or the last thing at night. If you try to flow it in the middle of the day you won't get very much.

MR. CULLER: The main idea, then, in introducing water is to keep up the level and maintain a supply of food for your smaller fish.

MR. HAYFORD: Just the same as you boys work it, practically. I changed my system to meet with a lot of things you checked and proved to be good.

A NEW METHOD OF STUDYING FISH ENVIRONMENT AND DETERMINING THE SUITABILITY OF WATERS FOR STOCKING

By David L. Belding

(Contributions from the Evans Memorial No. C 28)

Our present knowledge of fish environment has been obtained by direct observation. If a species was found to thrive under certain natural conditions, the environment was recorded as favorable for that particular species. From these detailed studies by many observers of the habits and environment of different kinds of fish we have obtained our knowledge of the natural conditions most suitable for these species. The extensive stocking records of national and state fish commissions, particularly the introduction of new species, furnish a wealth of information which can be utilized for the more exact study of fish environment. This paper describes a method based upon such records, water valuation, and biological surveys by which it is possible to determine in terms of end results the conditions which are favorable, unfavorable, and those which have no apparent effect upon the existence of certain species. It supplements and in some respects is superior to direct observation in the study of fish life since it is concerned with actual fish production in various types of environment.

Method of Work. From 1910 to 1913 an examination of the natural physical characteristics of the lakes and streams in Massachusetts was made. Subsequently, these lakes and streams were given a percentage valuation for different species of fish on the basis of the fish production and the quality of the fishing. Certain waters which had been stocked over a period of 10 to 20 years received a similar valuation based on the end results of stocking, thus affording in many instances an excellent control for the first method. By comparing the natural conditions in the productive and unproductive lakes, it was possible to determine the factors both favorable and unfavorable for the existence of several species.

In order to furnish a concrete illustration of this method, a single species, the small-mouthed black bass, has been selected. This fish which was introduced into Massachusetts in 1850 is now present in 269 lakes. These lakes may

be grouped from the standpoint of black bass fishing into four classes: (A) 49 lakes of excellent productive capacity; (B) 34 lakes which furnish a good yield; (C) 96 lakes with indifferent or fair production; and (D) 90 lakes of slight productive value. In Class A lakes the natural conditions are most favorable for the existence of the small-mouthed black bass. In Class D lakes small-mouthed black bass exist but conditions were unfavorable for their extensive development. If the average natural conditions for Class A are contrasted with those of Class D, the factors which comprise a favorable or unfavorable environment for small-mouthed black bass may be determined.

RESULTS. The comparison which is given in the accompanying table is self-explanatory. The area of a good small-mouthed black bass lake should be at least 50 and preferably over 100 acres, the average for Class A being 185 acres as compared with 85 acres for Class D. The depth should not be less than 20 feet and preferably over 30 feet. The latter depth in most cases would permit in small lakes during the summer a surface layer, a middle layer or thermocline in which there is a rapid fall in temperature, and a bottom layer of a uniformly low temperature. Swampy or dark colored, muddy waters and excessively muddy bottoms should be avoided and clear or turbid, light colored waters selected. Too little or scanty vegetation is unsatisfactory and excessive vegetation such as is found in the shallow warm water lakes is unsuitable. The character of the shores and the presence or absence of inlets and outlets have no bearing on the suitability for this species.

DISCUSSION. This method of studying fish environment offers a more reliable basis for stocking waters than the old method of direct observation. Lakes which possess the natural conditions of Class A are more likely to give better results for small-mouthed black bass than those with a different environment. Occasionally, a lake which varies markedly from the average may give good results. However, the chances of successfully stocking unknown waters are greater if the average favorable type is selected. A stocking policy based on an end result method, such as outlined here, should prove efficient in the hands of state commissions.

FAVORABLE AND UNFAVORABLE ENVIRONMENT FOR SMALL MOUTH BLACK BASS

Natural Conditions	Per Cent of Lakes	
	Class A (Favorable)	Class D (Unfavorable)
Area		
Below 50 acres	12	54
Below 100 acres	32	86
Depth		
Below 20 feet	21	57
Below 30 feet	44	85
Water		
Color		
White	39	21
Light Brown	50	30
Dark Brown	11	49
Turbidity		
Clear	56	21
Cloudy	33	30
Muddy	11	49
Vegetation, marginal and submerged		
None	23	17
Scanty	52	17
Dense	25	66
Inlets		
Present	33	33
Absent	67	67
Outlets		
Present	89	89
Absent	11	11
Natural Food		
Abundant	15	29
Fair	18	15
Scanty	67	56
Bottom		
Rock	17	17
Gravel	11	11
Sand	20	7
Mud	48	60
Carpeted	4	5
Shores		
Woodland	61	63
Cultivated	8	4
Uncultivated	21	18
Marsh	10	15

Aside from its practical value in connection with stocking inland waters, this method affords an excellent opportunity for the study of fish environment, especially of introduced species, since it contrasts the conditions which favor development and those which allow mere existence.

SUMMARY. A method of determining the most satisfactory environment for different species of fish is outlined. It is based upon the productive value and natural conditions of fishing waters. This method should prove of value in determining the suitability of new waters for stocking, and it may aid in establishing standards for the valuation of inland waters. It should serve as an appreciable aid to the student of fish environment and fish life.

MR. TITCOMB: Dr. Belding, as you know, has done a good deal of work in the survey of streams and ponds with reference to the establishment of a permanent stocking policy for them, and was Chairman of a Committee to prepare a pamphlet on Standard Methods of Making such Surveys. That pamphlet was published by the Massachusetts Fish and Game Commission, and I have no doubt you could get copies of it.

I commend to you a careful reading and study of this paper after you get it in printed form. It is a very valuable contribution indeed, coming from one of the most experienced men we have in that line in the country.

AQUICULTURE—OR WATER FARMING

By Lewis Radcliffe

Deputy Commissioner, U. S. Bureau of Fisheries.

As nations experience difficulties in supplying their wants from the land, they increase their dependence upon the food resources of the sea. The island empires of Great Britain and Japan eat more sea products per capita than those countries which are part of the main continental areas. In this country our available supply of unoccupied tillable land is fast disappearing. Indications are not lacking that history is repeating itself and that our dependence on water products will be materially increased. Permanent growth in this field must rest in considerable degree upon the development of the science of aquiculture which is still in its infancy. There are many factors involved in this subject, including climate, hydrography, recreation and reclamation.

The best known development of aquiculture is that of fish culture, chiefly prosecuted by Federal and State agencies. In this field we have given more attention to the mechanics of operations and much less to results of our operations on maintaining the supply. We need to give greater attention to the study of the particular organism, its capabilities of withstanding changes in conditions such as temperature, its food supply, the critical periods in its life, and how the losses at such periods may be minimized, its enemies and means of combatting them, and its diseases and how they may be avoided or eradicated. We must give greater attention to the rearing of fry to a larger size on larger scale operations. We must replace our drafts on wild stock for our supply of eggs with the more general dependence upon brood stock and then we must proceed to improve the strains of brood stock to increase their productivity and their immunity to losses.

Long ago we learned that a fish-cultural pond is something more than a depression holding a certain number of gallons of water. We realize that the water itself will differ in one pond from that of another; that for our venture to be successful the pond must contain an abundant supply of food suited to the needs of the particular organism; and that one type of bottom is suited to the needs of one fish and not to another, etc.

To achieve our highest aims, we must make the subject

a more exact science. We must develop a measuring stick that we can apply to any water area, and determine its suitability to our particular purpose and thus be able to select areas best suited to a particular need, and then we must know how to improve where it is deficient so as to produce a maximum yield.

Increasing the productivity of a pond area involves many factors including a satisfactory water-supply, control of the emergent plant growths; the artificial feeding of the fish with the types of food most productive of growth and health; fertilization of the pond itself, to make it produce the highest maximum yield of natural food organisms, etc. In Europe it has been demonstrated that the productivity of a given area may be increased several hundred per cent by artificial feeding. That to secure the best results, in addition to the supply of artificial food, the pond must have an abundant supply of natural food. In sterile ponds it was found that artificial food alone would not produce satisfactory results. The fertilization of the pond is a problem itself involving the subject of providing those things which will produce a luxuriant plant growth. We may add fertilizers direct or indirectly by the growth of a crop which is cut and allowed to rot. If we over-fertilize we may produce an oxygen deficiency and if we under-fertilize we do not obtain a maximum yield. We need to know how often the pond should be drained and used for growing a crop, the elements for which there is a deficiency in the pond, and those already in sufficient supply; whether the water is acid or alkaline and the correct amount of lime to add to produce the desired result. These are but hints at the complexity of the problem with which we are dealing but are sufficient to reveal the need for exact scientific studies if we are ever to deal with these problems after the manner they merit.

In addition to the work of Federal and State fish culturists there are between 50 and 100 commercial fish culturists, who produce trout eggs to the value of about $200,000 per annum and dispose of their surplus stock of trout at fancy prices. Our annual output of goldfish is probably not less than 20,000,000 fish valued at $350,000. Oyster farming is now developing with about 150,000 acres of grounds under lease. Considering the suitability of our coastal waters to this crop, it is conceivable that we may double or treble our present harvest of 18,000,000 bushels

with the further development and improvement of cultural practices. For in the final analysis we must place our dependence on the cultivated grounds and not on natural rock. This brings us to the question of productivity of water areas. It has been estimated that an acre of cultivated land will produce 140 pounds of beef, 300 pounds of pork, 800 pounds of wheat, and 1,700 pounds of corn. An acre of water under proper cultivation will certainly produce between 100 and 150 pounds of fish such as carp, and a much larger yield of shellfish such as oysters or mussels. While aquiculture is still in its infancy, I am convinced that we shall be able to develop water farming to the point where it will be as productive of protein food as a similar land area.

We are facing an era of unprecedented expansion along these lines and we should therefore take stock of how we are building up this science. Pollution, deforestation, reclamation, super-power development with the construction of dams and barriers to anadromous fishes, the construction of good roads and the increased use of the automobile have contributed to the difficulties of keeping a wild stock of fishes in our streams. Man more than ever must supplement nature to provide good fishing. On the other hand, the super-power development is providing large bodies of water where heretofore there were only small streams. How can we make these water areas productive of the maximum yield of fish in the shortest possible time? What a wonderful subject for aquiculture study some of these bodies of water will make. As evidence of this increased interest I would call your attention to the growth in numbers and strength of fish and game clubs of the last few years, of the lively interest that is being shown in cooperative fish nurseries developed under the auspices of the Bureau of Fisheries and of the growing demands for better conservation laws and their enforcement. Important legislative enactments have been sponsored by the commercial fishermen, who realize the need for insuring the continuity of their business as does the angler for providing good sport fishing.

Discussion.

MR. WAGGONER: I would just like to ask one question. A number of these large dams are being constructed in our states for the purposes of hydro-electric plants. What effect would the raising and lowering

of the water caused by these works have upon the propagation of fish?

MR. TITCOMB: In our part of the country that same development is going on, and we are really getting some valuable fishing waters. Where they have built these immense storage reservoirs for the purpose chiefly of saving the entire volume of water which would pass away from the watershed during the freshets, it would seem to me to be a good thing. So far as we have observed the results in New England, the power companies are inclined to cooperate with us in keeping these reservoirs open to public fishing.

MR. QUINN: We are confronted with that situation in Alabama. When the program of the Alabama Power Company and other power companies in our state is completed we will have perhaps the largest area of impounded waters of any state in the Union. The period of spawning of our principal game food fish comes at that season of the year when a considerable draught on our impounded waters will not amount to very much. In other words, the draught comes late in the summer, at a time when there are very few fish spawning. Now there is one exception to that. One of the largest impounded bodies of water we have is a lake about thirteen miles northeast of Montgomery, with a dam something like 150 feet high, and covering miles and miles of area on the Tallapoosa River. The bottom is so constructed that it forms a narrow, deep basin, backing up into a comparatively level area where we have several miles of extremely shallow water. In our bream spawning period there would be a considerable drawing off of the water from those shallow areas where the bream are accustomed to spawn, and that will greatly interfere with the bream. It will not interfere very much with the bass, because the draught on the water will not come at the season when our large-mouth bass are spawning. To correct that I have this proposition: This lake is owned by the Alabama Power Company, and I think we will be able to have that company, which is tremendously interested in sports, especially in fish back of their dams, construct small dams in their tributaries so that when the fish pass up the streams to spawn they will be able to do so in small secondary impounded bodies of water, and do it at the proper time. This water, of course, will be held impounded with smaller dams in the branches of the river tributary to the lake. After the spawning season is over these tributary dams will be opened up and the fish will be brought back down into the main lake. I think that will work out very nicely if we are able to put the project over. It will cost the power companies several thousand dollars, but I trust they will be willing to do it. If this is a new suggestion to you in regard to dealing with matters of this kind, I hope you will take it for what it is worth.

MR. TITCOMB: When the question was first put I had in mind these immense artificial lakes which are built very frequently on streams that are to-day comparatively unproductive. But another development of these projects has taken place during the last few years. At the outlets of natural lakes the corporations have acquired certain rights from the little mill owner who formerly operated a saw mill or grist mill there, and have proceeded to raise the level of the natural lake. In many instances these waters are surrounded by summer cottages, and the land values around the lake are quite large. There has been a tendency in summer time, at the period of drought, to draw the lake below the normal water level. In other words, these wealthy power companies have supplemented or replaced the old log mill dams of the saw mill owner with a concrete construction for an outlet which is permanent and substantial. Sometimes they reduce the lake very much below the normal water level. The states really ought to have legislation through their Utilities or Public Service Commission whereby the low water level of all the natural lakes is officially recognized; otherwise in many instances the cottages and boat houses may be found high and dry during the period of drought.

These developments are adding to our wealth, but where they are not using the water immediately below the dams but are carrying it by during the periods of drought, you will find that the river bed immediately below the development is sometimes absolutely dry, with a resulting effect upon the breeding areas and upon fish life generally over miles of stream below the new development. We have a problem of that kind now at two different places, and we have got to interview those interested in the development.

MR. PETTIS: In Roosevelt Lake in Arizona the bass spawn well in some years but not in others. If there is plenty of snow on the mountains and the conditions generally are favorable in that respect, the bass nests should be all right. But if there is no snow on the mountains and the water does not come off in such a way as to maintain the lake levels, the lake keeps going down six or eight inches a day; the bass nests soon are left on the gravel beds, high and dry, and that year we do not have a crop of bass. Our bass do not take to those streams that feed the big lake; they get out on the edge of the lake and as the water is drawn down we lose a large percentage of our bass crop.

MR. MANNFELD: Mr. Titcomb has explained the situation that exists in Indiana with respect to these hydro-electric companies. Perhaps you have heard of the Tippecanoe River. Concrete dams have been built there in two places, one of them at Norway, about two miles north of Monticello, a dam thirty-two feet high by which they have backed up the water some twelve miles, making a wide expanse of river or lake. It is a great fishing place, but here is what occurred

when they filled this basin: they did not let the water through the river as they should in filling, and they did this work just about the time the bass were spawning in the spring. One of our game wardens who lives at Monticello gave his entire attention to watching what was going on along this river. About two miles below this Norway dam was an old dam that had been used by some mill, and that helped the situation a little, but when they stopped the water entirely there were only a few holes in which the fish could congregate, and 52 small-mouth bass nests were counted there, high and dry. The violators thereupon came down with nets and began to take the fish out of these mudholes. We rescued a good number of the fish and put them above the dam. A little later they built another dam some twelve miles below this one, and during the week-ends, when they have no particular use for the power, they shut their gates and the river goes down as much as six feet. The Tippecanoe, as you know, is a wonderful bass stream, but one day you have a river and the next day you have nothing but a little straggling stream that you can wade across. We have no power whatever to control that situation; in fact we are asking all the land owners below to do something in the matter. The riparian owner can get redress by filing an injunction or instituting a damage suit, but at the same time the state ought to get some benefit out of this particular river, yet there is no regulation in our state on the subject. I believe it is very important that this Society should take the matter up and recommend that state legislation be enacted to enable the Fish and Game Department or the Department of Conservation to make regulations. Of course we have supervision over navigable streams, but we have only one navigable river, the Wabash; all other streams in our state are declared non-navigable, and we have no jurisdiction over them; there is a special law in connection with the creation of the Department of Conservation that gives us control. When sand or gravel is taken out of the Wabash River the companies are required to pay into the state treasury so much per yard for the material taken out. These corporations are going through our state in other sections and building hydro-electric dams, and it is giving us quite a good deal of worry; it is going to ruin some very valuable bass streams. I understand that in Kentucky—Mr. Waggoner would know about this—there is a project to bridle Cumberland Falls, which has been opposed by the Governor and a lot of other good citizens of that state. Perhaps he can tell you something of his trouble there. He is just beginning to get it in his state; we have already got it.

PRESIDENT HAYFORD: Perhaps I may say just a word in regard to that. Of course we do not have any such water developments in New Jersey, but when I was in the Maine Department we did come up against that question. We got a bill passed in New Jersey that we think is a good

measure. We did not have any difficulty in passing it, because we made no attempt to put teeth into it. This law provides that you cannot draw any pond or lake in the state without notifying the Fish and Game Commission, making it an offense to unnecessarily destroy fish. If we are careful whom we send out to meet these people we can nearly always get a promise to work co-operatively with us, and that arrangement has been satisfactory so far.

MR. MANNFELD: The great trouble with us is that the company agreed to do that very thing, and they have not so far carried out their agreement. If a normal flow of water is allowed to go through it is all right, but they do not do that, although they have agreed to do it. Then they always blame it on some foreman or something of that kind. It is a bad situation. I realize that power development is sometimes more valuable than the maintenance and propagation of the fish, but we can have them both. I am not objecting to dams; I think they are beneficial when they hold the water back and provide deeper waters for fish to live in. The Shafer Lake is considered one of the best fishing places in the state of Indiana to-day, and there is a fishway—they have complied with the law in that respect. But the situation has not been properly handled, and we cannot force them to do anything.

MR. LECOMPTE: May I ask Mr. Quinn a question with reference to the Alabama Power Company? Does the Alabama state law make compulsory the building of a fishway or fish ladder at the dam?

MR. QUINN: Our statute provides that all dams twenty feet and under, constructed for commercial purposes or otherwise, must be provided with a fish ladder. But the converse is true; dams constructed for commercial purposes above twenty feet in height do not require a fishway.

MR. LECOMPTE: What is the height of the dam constructed by the Alabama Power Company to which you have referred?

MR. QUINN: They have a number of them. One of them, on the Tallapoosa River, is 150 feet high at its highest point. The Tallapoosa River is a navigable stream and there are no game food fish in it, because it comes down out of the mining district of Georgia. As it is muddy the greater part of the time, only such fish as drum and buffalo are found in it. But the backwaters, where the mud and silt have settled and clarified, are a wonderful place for game food fish such as bass and bream.

MR. LECOMPTE: Of course your waters can only be navigable as far as the dam. We are having a great deal of trouble in the state of Maryland with the Youghiogheny Hydro Electric Power Company. In 1923 they began a development in Garrett County in practically our only trout territory. They placed a dam on Deep Creek, impounding

the waters of Deep and Cherry Creeks, I should say of at least 100 feet. They have impounded a lake there twelve miles in length and running from one-half a mile to a mile in width, raising the level from ten to sixty feet. At present, of course, that is making an excellent spawning ground for trout, but it has eliminated the waters below the dam for trout territory; in fact it has cut off I should say at least a distance of twenty-five to thirty miles of excellent trout streams. After this dam was erected and the lake formed, we found there was no water, as Mr. Mannfeld has stated, below in Deep Creek, at times for probably half a mile. That killed the vegetable matter in the stream; and that is only one case. There are many others.

MR. TITCOMB: With reference to mill ponds, we had a case two summers ago where the sanitary officer had to remove fifty bushels of adult fish that were dead or dying. We did not get word of it in season to save them, but as a result we got a bill through the legislature requiring all dam owners, whether individuals or corporations, to notify the State Board of Fisheries and Game when they propose to draw a pond to the extent that it may jeopardize fish life. Below these ponds in many instances the waters are not suitable for the species inhabiting the ponds. When notified that they propose to draw the ponds we take measures to save the fish, moving them into waters where they will be of use.

Reference has been made to the construction of fishways. I suppose 99 per cent of the fishways that are constructed never amount to anything. I think it is a shame to require a corporation, whether a hydro-electric or otherwise, to build a fishway which you can say in advance will not serve the purpose, being merely a waste of money.

MR. LECOMPTE: I do not agree with Mr. Titcomb that it is a waste of money. For instance, take the McCall's Ferry dam on the Susquehanna River: We must admit that there are very few shad going over, but during the spring freshets when the water is running through there from ten to fifteen feet deep, some fish can go over.

MR. TITCOMB: Shad?

MR. LECOMPTE: Yes, and all other species that want to; therefore I think our legislation is all right. If you can not save one hundred per cent of the fish there is no reason why you should not save twenty-five per cent if you can.

FURTHER OBSERVATIONS ON THE BASS FLATWORM—PROTEOCEPHALUS AMBLOPLITIS

By Emmeline Moore

New York State Conservation Commission.

My report to this Society last year on the bass flatworm was in the nature of a bulletin announcing a serious condition among the bass on account of the presence internally of a proteocephalid worm. A brief description was given of the nature of the parasitism and its pronounced effect upon the reproductive structures.

For the benefit of those who are unfamiliar with this malady among the bass, I will describe a typical case: There is no external evidence of infection except in advanced stages of the disease when the body shows a slight bloat. The characteristic lesion in a heavily parasitized specimen is clearly shown by slitting open and exposing the organs of the abdominal cavity. It will then be observed that all peritoneal tissues and the viscera as well are bound together and to the body wall in a more or less solid mass by fibrinous adhesions, these being abnormalities caused by the encysting larval worms. Several hundred worms may thus be seen either encysted in yellowish-white irregular capsules or migrating about as larvae through tissues that are soft and penetrable, the liver, spleen, pancreas, peritoneal tissues and the reproductive organs. In these latter organs infestation by the worms inhibits the development of both egg and spawn and promotes general sterility. No worms have been observed in the flesh. The larvae are small, flat, white, glistening worms with four round sucking disks at the head end. The worms vary in size according to age from an eighth of an inch to about an inch and a half in length and from about a sixteenth to a twelfth of an inch in width. Recognition of this infection is unmistakable because of the adhesions to the body wall and the spread of the parasites in the encysted and active larval stages over all exposed tissues.

The interval of a year brings to light additional information indicating what manner of worm this is, its occurrence and distribution and the seriousness of its presence under hatchery and pond conditions.

So far as its distribution is concerned, evidence is accumulating that the parasite is widespread in our northern

waters, though as recently as 1914 in a monograph on this family of worms by Dr. George R. La Rue, it is stated that this species is known only from waters in the St. Lawrence River drainage system and the Red River of the North. Numerous letters have come to me from bass anglers and others describing this condition of parasitism as existing in lakes they have fished in New York State, Maine, New Jersey, Connecticut, Wisconsin and Ohio. There are records of its occurrence also in Missouri, Michigan and Minnesota. Information has come to me that some bass hatcheries have sustained a total loss this year on account of the heavy infestation of the worm and the consequent inferiority of spawn.

In Barrett Pond, one of the small lakes in the Croton Water Supply system of New York City where I have made frequent examination this year of afflicted bass, it may safely be said that at the present time all of the bass in this lake are excessively parasitized, likewise all of the sunfishes of which there are two species in the lake, the long-eared and speckled sunfishes. Few bass over 14 inches in length are now caught in this lake. No well-defined schools of bass fry or fingerlings have been observed this season. Dead bass are not found. It seems a clear case of extermination through lack of reproduction.

It is reported that the large-mouth bass is immune from this disease. Quite the contrary is true. Mr. R. V. Bangham who is studying conditions in Ohio and I myself have observed similar and heavy infestations in this species. A relatively higher resistance to the parasite may exist where both species have been observed side by side, but there could be but seeming immunity.

The parasite may appear very early in the life of the bass (Bangham, 1925). Fry about 10 days old in Barrett Pond harbored them in such stages of development as to suggest infection soon after hatching. In general I have found the infection light in the young stages but increasing in severity with age.

So far as I am aware the life cycle of not a single member of this family of worms is completely known. My observations show that the bass may harbor the larval worms in the viscera as described and the adult worm in the intestine. Further than this I have no exact proof. Mr. Bangham is attacking the problem in logical fashion through the medium of the food ingested by the bass. He postulates

the theory apparently with some reason that an intermediate host, a copepod or other crustacean used as food, furnishes the method of incidence into the fry or fingerlings. His theory gains plausibility since, as he states, he has found such an intermediary relationship existing in a closely related species of worm. If such is the case, the infected copepod introduces the parasite into the fry and fingerlings; then according to his theory, an infected small fish eaten by the bass may be the conveyor of the worm into the adult bass.

Recently I have been looking into the plankton at Barrett Pond where the parasite is rampant. I do not find that the copepods are carriers—though I may be mistaken in this. Curiously enough in most cases the gills of the basses and sunfishes have every appearance of being stung by some minute, free-swimming object. Seemingly the soft tissues of the gills could be readily penetrated by the minute embryo of the worm and find there a suitable, temporary abode for the transformation of its initial stage, later passing to other penetrable tissues until the body cavity is reached. However, these observations are too recent to be of more than speculative interest.

In the Genesee River and tributaries of the watershed, the bass are practically free of this parasite. I found but a single worm or two in each of five out of forty or more specimens which I examined. It is interesting to note in this connection that in sections of this river characterized as good bass waters, natural reproduction was abundant and apparently sufficient. Fingerling bass reared at the state hatcheries at Oneida and Ogdensburg show freedom from the disease. According to Mr. Bangham the parasite is unknown in the Ohio River drainage. Of course there are other instances of freedom from this pest, so that the situation regarding the bass seems not altogether hopeless.

Summarizing the general observations that are now before us, we find that since 1914 the boundaries of infection have been widely extended, presumably through lack of application of quarantine methods in our stocking policies; that the young may become parasitized on leaving the nest; that this type of parasitism affecting the spawning function strikes at the heart of the reproduction of the species; furthermore, that all members of the Centrarchid family, including the basses, sunfishes and crappies, are strongly susceptible to this parasite.

The imperative thing to do in an endeavor to check this menace among the bass is to complete the life history of the worm. The formulation of any constructive plan of action will await these facts. Remedial measures for ponds or small lakes may be as simple as a light dosage of copper sulphate at the time the embryo worms are swarming in the water. Because so much mystery still surrounds the life cycle, it means pioneering work in a difficult field requiring highly specialized training with adequate equipment and funds.

For a complete understanding of the situation it is essential to have comprehensive and searching surveys. Bass anglers can help by reporting the condition of their catches. States organizing surveys should include this feature in their programs of investigation.

Discussion.

MR. DOZE: Dr. Moore's paper is of extreme interest to us, because we have working at the present time Dr. Mina Jewell, of the Agricultural College at Kansas, on this very subject—the presence of the flatworm in the black basses of the Cimarron River district of Kansas. Some of the most wonderful bass fishing in the West occurs in the spring fed streams back from the Cimarron. Dr. Robert K. Nabours, head of the Biology Department of the college, assigned Professor Ackert, a parasitologist, and Dr. Jewell, with the assistance of a graduate student, to make some scientific investigations at the expense of the Fish and Game Department. They are working on snails, and they have found a cyst in the snail which they have not been able to transfer to the fish, although they have tried it in numerous ways. They have found in the hatchery at Pratt some evidence of the flatworm in a few of the fish, but not all. Their investigations, which are not complete, will be summarized in a bulletin to be edited by Dr. Jewell and to be published probably about next spring. It will give me pleasure to send a copy of it to any members of the Fisheries Society who are interested in this particular subject. It is their theory—they have not gone far enough to be certain—that the birds are part of the life cycle of this worm. They have found evidences of that in the bitterns and herons, although what part they play in the cycle is not known. One suggestion they make to rid a stream or pond of this flatworm is to bring down the pond as low as possible, let it dry, and then burn all the vegetation. Their theory is based on what happened in Scotland, where, in order to get rid of a certain parasite, they destroyed all the snails in the swamp, whereupon the parasite disappeared. So they

are working along the theory that if you destroy one part of the cycle you will eliminate the flatworm.

It appears that the attack of the flatworm has spread in our state; they are found in streams now where they were not known a few years ago, or at least where they were not observed. It may be that they were there but the folks were not so observant.

MR. VIOSCA: I am wondering if any of our fish culturists here have ever considered the possibility of our predacious and scavenger fishes such as the gars having a tendency to destroy the parasite-carrying species. In the state of Louisiana we have a great abundance of the two species of gars, and our fish are seldom if ever troubled with any serious parasitic diseases. It may be that the gars, by destroying the sick fishes, are doing away with the parasites. Our southern gars do not take vigorous, lively fishes; they prefer the sick or the dead ones.

DR. EMMELINE MOORE: I would like to ask Mr. Viosca if the gars he speaks of are the same as we have in the Ohio drainage. Is it the long nose?

MR. VIOSCA: We have three species. Our abundant gars are not the long nose. We have the alligator gar and the short nose gar; they are the two abundant species in our waters.

DR. EMMELINE MOORE: All gars seem to have a tendency towards scavenging.

MR. VIOSCA: Our gars have a tendency to prey on dead fishes. The long nose gar seems to be more active and follows the healthier and more vigorous fishes.

PRESIDENT HAYFORD: I am not well enough informed to talk on this subject, but I just want to cite one instance in connection with the point that was raised yesterday as to the bass becoming dwarfed and the attributing of that condition to lack of food. In our case it was not lack of food; it was this intestinal infection. None of the bass in this instance that was brought to my attention attained a size of over thirteen inches. The thirteen and fourteen inch bass were the large ones; most of them were from ten to twelve inches. The lake that these bass came from used to be thickly populated with small-mouthed bass of from three to five pounds.

MR. VIOSCA: Yesterday afternoon I was engaged in conversation with some of these Alabama men in reference to the extermination of gars in Alabama, where they seem to be abundant. But before the state of Alabama spends a considerable amount of money in an effort to exterminate alligator gars, I suggest that they devote the same amount to an attempt to ascertain the relationship between gars and other predacious fishes to the parasites of the fishes of their state.

MR. QUINN: I just wanted to say this about alligator gars. There is a one hundred per cent opinion in Alabama that the alligator gar is

destructive of our game fish and ought to be destroyed. Now, the thing is what to do about it; but Alabama has never spent any money on it. In Bon Secour River, just across the bay here, in Baldwin County, I believe if you were to go over there with me you would be convinced that for the amount of water there are more large-mouthed bass there than will be found in any body of water of similar size on the North American continent. I do not believe there is another stream of its size on the North American continent that has so many alligator gars. I do not know whether the bass and the gar do well together or not.

MR. VIOSCA: So far as my experience in Louisiana is conncerned, if I want to catch large-mouthed black bass I always look for a place where the alligator gars are abundant, because there seems to be plenty of them in those streams.

PROGRESS OR POVERTY THROUGH REGULATION OF POLLUTION OF PUBLIC WATERS

By George W. Field

Henry George saw "the rich getting richer, the poor getting poorer" with the antagonism of capital and labor, man against man.

Today we see rich and poor getting together, both getting richer, but Nature getting poorer, declining in natural potential productiveness. True, we have learned to recognize that capital and labor are identical in fact and function, and that civilization has progressed through the increasing cooperation of capital and labor. However, the net result is, too often, mankind organized against Nature's Laws and Resources.

Unfortunately, we must still ask, to what extent capital and labor have unwisely robbed, and still are robbing Nature, for the purpose of investing the proceeds in what must be recognized as less important public and private enterprises. Considerable data has already been made accessible, particularly concerning the uneconomic practices in handling our forested and grazing areas, our wastes of soil fertility, and of our economically unwise drainage projects, but relatively little has been ascertained of the true facts about the age old practice of polluting the public waters; to what extent has the practice grown; under what conditions is it justifiable; what is the resulting biologic threat to continued national progress in health, wealth and the pursuit of happiness.

Every member of this conference should read carefully and assimilate the facts marshalled by Professor S. A. Forbes in "Outdoor America" for September 1926. Professor Forbes is the pioneer and the outstanding student and authority on the biological facts of sewage pollution.

The nomadic races pollute the land and water, but move on, and give the biologic process of Nature a chance to function in converting inorganic material to organic and vice versa, i. e., the bio-chemical cycle of matter.

The go-mad races excessively organize and concentrate activities, and consequently produce wastes in such cumulative and destructive quantities that Nature, unaided, cannot carry on the all-important bio-chemic cycle of matter. The result is ultimately catastrophic, of which the admonitory symptoms are water borne diseases like cholera, ty-

phoids, various dysenteries, and other direct taxes upon human efficiency and happiness.

The present frequent practice of "civilized" man is to meet this problem only after it has become burdensome, and then provide the cheapest possible temporary remedy. The untreated sewage and trade wastes of at least twenty-five millions of urban population now enter our public water courses, in quantities so localized as to seriously impair natural and necessary biologic processes.

Preventive medicine is being found to be a sound economic investment. Prevention of pollution is certain to be found of still greater economic advantage, as soon as all the facts are ascertained and marshalled for public information.

For more than two decades the American Fisheries Society has given ear to varied detached observations and statements. These two decades carry aspects both of progress and poverty. The Massachusetts Fish and Game Protective Association, the Coastal Anti-Pollution League, and numerous other organizations, merging efforts in the National Conference on Outdoor Recreation, have called upon the Izaak Walton League to accept responsibility for carrying the torch of progress, and to illuminate the path towards regulation of the pollution of public waters, with economic justice to Nature and to all human interests. This is really a great and important problem, calling for the utmost cooperative effort.

WHAT PROGRESS TO DATE

Today most states have anti-pollution laws; too often ineffective in operation as a result of divided executive authority,with the consequent uncertainties on the part of officials and of the people. Pennsylvania, New Jersey, New York, Ohio, and Connecticut have made progress in eliminating this pernicious defect.

The Federal Oil Pollution Act of 1924, followed by the International Conference of 1926 has provided a partial remedy for conditions of the Coastal and the High Seas.

The Wilson Bill now before Congress, if passed as it should be, extends similar provisions to the Inland Waters. It is a most important measure. It may possibly be opposed by the organized oil interests.

The right to pollute the waters has been recognized by law in cases where a riparian owner, by utilizing the mechanical and biological capacity of waters to dilute and mineralize (oxidize and nitrify) certain kinds of polluting

materials, can purify them to the degree necessary to permit natural biological processes to function and avoid a local nuisance.

We should consider whether misuse of public waterways in the interest of immediate "cheapness" in disposal of wastes has not already produced a far greater economic loss to the public than gain to individuals, corporations, and communities.

Among others, New York and Chicago elected to take the "cheap" way to handle their wastes. Outraged nature and distant communities, buncoed and imposed upon, are now rising in protest against the economic injustice. Chicago appears willing even to threaten the impairment of our treaty obligations with respect to the Lake waters.

Will not further delay eslewhere make conditions still more serious? It is easy to hoodwink public criticism by statements that "plans are under way, and will be carried out as soon as you vote to tax yourselves to pay the bills".

In order to correct the unfavorable conditions which now exist adequate methods for regulating pollution at its source must be applied. The idea must be developed that those who pollute public waters shall be educated to see their responsibility to correct the pollution. Public sentiment must demand that those who are polluting public waters shall cease the pollution.

1. So great is the number of factors, and so permutated are the combinations, that almost every case of pollution must be scanned and analyzed before it can be correctly treated. In other words, trained biologists and chemists should be called on to prescribe for sick Nature, rather than to subject the patient to further treatment by political quacks acting directly or indirectly, voluntarily or ignorantly, as agents for vested interests or entrenched selfishness.

2. Business, both big and little, must accept the fact that it is "good business" to make adequate provision for caring for its wastes and include it as part of the cost of production, and not slip this over as an unjust and unsuspected tax burden upon others.

3. So great are the numbers of factors and combinations that each case of pollution should be analyzed by trained biologists and chemists rather than by professional publicity agents.

4. It will be cheaper for the purchaser to pay a fractional percentage of increased retail cost, rather than to have to pay in the general tax levy, an aggregated sum increased a hundred or a thousandfold. We sometimes "win out"

in business competition at too great discount of the future. To take but a single instance; have we not sold beef, lumber, paper, oil, fish, and numerous manufactured products in the world market without counting as a part of the cost of production, the crippling of our Nature, in forests, grazing lands, lakes and marshes indispensable for water storage and for breeding and feeding places for valuable fishes, birds and aquatic mammals; even in the case of oil wastes threatening the extinction of aquatic species, and even impairment of climate, over and beyond the personal annoyance and the potential menace to health and to important means of recreation.

The National Conference on Outdoor Recreation has requested and authorized the Izaak Walton League of America to proceed to extend all possible aid in further progress in wisely regulating the pollution of our public water courses, to the end that Nature may not become pauperized, with the resultant poverty to industries and communities which is certain to follow the incidence of the biologic law, that all organisms tend to become limited in growth or even destroyed by the end products of their own activities.

WATER POLLUTION IN LOUISIANA

By Percy Viosca, Jr.

Biologist, Department of Conservation, State of Louisiana.

SUMMARY

The streams of Louisiana into which waste products are discharged might be considered as of three general types: rivers or flowing streams of large volume in which pollution is slight if at all; bayous or sluggish streams with little or no current in which there is great depth in proportion to aerated surface and purification is largely biological; upland, relatively rapid streams of small volume, purified perhaps more by physical and chemical, rather than bio-chemical factors.

The different types of polluted waters result largely from oil wastes, paper mill wastes, sugar mill wastes, gravel washings, miscellaneous trade wastes, city sewerage and drainage, and various natural conditions.

Oil wastes are varied, resulting from oil tanker discharge; refinery wastes, both oil and chemicals; and oil field wastes, both oil and associated salt water and minerals dissolved therein. Conservation or trapping of oils, and checking of other wastes by means of reservoirs are the methods of correction suggested.

Paper mill wastes are threefold; pulp, alkaline calcium carbonate sludge, and wash waters in which organic salts of sodium are involved. Greater efficiency in the plants and batteries of settling basins suitable for restoring biological stability to the wastes are suggested as corrective measures, as well as the possible utilization of the wastes as a fertilizer.

Sugar mill wastes are largely sugars and associated organic matters lost accidentally or in washing the vacuum pans, etc. Dry land irrigation combined with the use of fertilizer, or fermentation ponds or cess pools would correct this evil.

Gravel washings do not directly kill fish but in various ways render streams unfit as fishing streams and pollution is shown to be absolutely unnecessary and unjustifiable.

Miscellaneous other industrial wastes not discharged with city drainage or sewage are largely organic in nature and present individual, usually simple problems of correction.

City sewerage is usually taken care of in our larger streams and gives us little trouble from the fisheries standpoint.

City drainage, combined with trade wastes contained therein, especially in and near New Orleans is giving considerable trouble and spoiling some of the best fishing streams and playgrounds near that city, and engineering projects for their correction are necessary.

Natural pollution is usually due either to deficient oxygen during cloudy summer weather or poisoning by decomposition of blue green algae, and can be corrected in some instances by conservation of water levels by preventing useless drainage. Potash and other mineral ash from forest and grass fires contribute to the pollution of our streams.

Louisiana is now prepared, as a result of these studies, to enter upon a period of sane constructive development of those aquatic resources which have depreciated because of needless pollution.

As the result of a general study covering several years past, of practically all of the streams, lakes and other waters of the State of Louisiana, in which pollution of some kind or another has been called to the attention of the Department of Conservation, it has been learned that there are several fundamental factors which determine the general character of these polluted waters.

In the first place we usually have larger volumes of water for dilution of our wastes, both actually and in proportion to our population and industries, than is available in other states where pollution is a more serious menace. Since most of our centers of population are along our four master streams, the Mississippi, the Red, the Ouachita and the Atchafalaya, we have usually no serious domestic sewerage problems, and our industrial wastes often go unnoticed to the sea, when dumped or pumped into these streams. It is in these, particularly, that purification by dilution does much to lessen the burden which would otherwise rest upon our shoulders by bringing about quick action by mechanical, chemical, and bio-chemical purifying factors.

Throughout the lower alluvial plains of the Mississippi the land drains away from the main streams. Therefore, towns and industries often discharge their wastes into the neighboring bayous and canals. There being little incline in these channels especially near the coast, the currents fluctuate from two miles per hour after a rainfall to no flow in dry weather and may be reversed by high tides. Since our bayous are relatively deep and the surface, therefore, small in proportion to volume and flow, and as there are no ripples, eddies or falls, which assist mechanical oxygenation to an appreciable extent, natural purification in

such streams is largely due to bio-chemical activities. Owing to our relatively warm winter climate these processes go on, although at a reduced rate, even at that season of the year.

In the upland regions of Louisana, where we have running streams flowing into instead of away from the master rivers, the character of the polluted waters and their purification corresponds more with the general run of polluted streams in other states.

The materials which pollute the waters of Louisana may be classed under oil wastes, paper mill wastes, sugar mill wastes, and other industrial wastes, gravel washings, city sewage and natural pollution.

POLLUTION BY OIL

Oil tankers, serving six oil refineries and several storage fields, as well as oil burning vessels which dock at New Orleans, make an immense source of floating oil scum. Streaks of oil generally float down streams where the drift, pilings and sand become impregnated with a tarry scum that collects in eddies under the docks. Several serious dock fires have been attributed to this hazard.

Our bathing beaches are saved to some extent by the fact that the stream carries the oil out into the gulf forty miles from the nearest bathing resort. There is some contamination, however, and the reason why we have not heard an outcry is that the best beaches are not reached by any rapid means of transportation. Our coastal fisheries are not affected because of the large volume of water and geological conditions in the delta of the Mississippi.

The fish in the Mississippi have never been affected by oil scum below Baton Rouge. The Standard Oil Refinery recovers its chemicals, and the leakage oils which are trapped in reservoirs are pumped back to the refinery.

Traces of oil and other compounds affect the taste of the water near the east bank of the river but these are soon lost on account of dilution. The water supply of New Orleans was affected once by this pollution, and shrimp taken from the river below Baton Rouge cannot be eaten because of an oily taste.

On August 19, 1921, acid wastes from an oil slop tank at the Standard Oil Refinery entered University Lake, destroyed all fish and other aquatic life and the lake has never recovered.

Wastes from oil refineries enter the canals back from the river. All fish and other forms of life in these streams have

been wiped out for distances reaching twenty miles from some refineries. The shores are unsuited to growths of aquatic life and have become a menace to people who seek food or recreation there. Sulphuric acid causes most of the trouble. This is eventually neutralized and then microscopic plants, fish and aquatic animals begin again to grow. The oil refineries have corrected the oil waste problem for economic reasons largely, but emergency traps consisting of baffles in earthen reservoirs would check the discharge to a large extent. Such reservoirs would permit of the disposal of oil by burning and would aid in the purification of other wastes by biochemical activities.

Oil washed from the streets, garages, etc., into the streams causes a dark discoloration, but this is volatile and disappears eventually.

The oil wastes and salt water from the newly developed oil fields pollute the streams. They have spoiled the former city water supply of Shreveport, but by building more efficient oil traps much of the crude oil can be saved. The salt water from the wells contains six per cent of sodium chloride, six-tenths of one per cent of calcium chloride and traces of other minerals. Upon exposure to the air a rusty colored carbonate of iron forms. This affects fish in two ways, first, by absorbing the oxygen in the water the iron salts rob the fish of this essential, and second, by forming a flocculent deposit on their gills smothers them by preventing them from breathing.

One remedy suggests itself for this evil. By constructing a battery of shallow reservoirs at the source, complete oxidation will be reached, the iron deposits will settle out, and the salt concentration can be taken care of by "dilution", if the stored waters are discharged only in the rainy season when the rivers are in flood.

POLLUTION BY PAPER MILL WASTES

Six paper mills using the sulphate process manufacture Kraft paper from pine wood. The wood is digested in a solution of sodium hydroxide and sodium sulphate. The resulting liquors contain about 50% of organic matter consisting mostly of gums and resins. This "black liquor" is evaporated, the organic matter being burned in the furnaces, and the soda recovered as sulphide and carbonate. The latter is causticized with lime forming caustic soda and carbonate of lime. There are two other waste products, soda combined with organic compounds, and pulp. Of all the

types of wastes emanating from the mills these organic salts, by decomposition, form the greatest trouble in our streams. This pollution purifies itself rather rapidly, however, when checked in shallow swampy areas that permit of oxidation and sedimentation aided by the activities of fungal organisms. This purification takes place as follows,—bacteria and fungi develop in the organic mill wastes; protozoa then becomes established; followed by the growth of microcrustaceae, midge larvae, snails, tadpoles, top minnows, crayfish, mussels, and finally fish.

The loss of pulp has been checked by installing efficient screening devices by which "lost fibre" is recovered and carried back into the systems.

A battery of shallow ponds, with large surfaces exposed to the oxygen of the air, and growths of various organisms concerned in the purification processes, if flushed out only during heavy rains will prevent the organic constituents from injuring the waters of any important streams.

Wash waters that are too weak to be evaporated at profit may be used over again, and the deposits of calcium carbonate, cellulose, and organic matter that collect below the mill are very valuable as fertilizer for neighboring farmers.

POLLUTION BY SUGAR MILL WASTES

The sugar mills of Louisiana are mostly located in alluvial lands. The damage which their wastes do occurs during the cane grinding season when most of the sugar mills allow their drainage to flow into sluggish bayous or canals.

Investigation has proven that the decomposition of sugar, gums, and organic matter, emanating from the plants, kills the aquatic life in the streams by the consumption of oxygen. Hardy game fish may struggle at the surface for air for several days before dying, and such species as gars and minnows may not die at all.

The organic wastes from the sugar mills consist largely of drippings, floor washings, and liquor discharged from vacuum pans. The solution of the problem of sugar mill wastes pollution is simple as they can easily be stored in cheap settling basins where sedimentation and biochemical action will purify them readily. The volume of settled waste matter is small and can be used for irrigation to advantage as it is valuable as a fertilizer.

POLLUTION BY GRAVEL WASHING PLANTS

Sand, discharged from gravel washing plants and run into the streams, fills the natural holes and irregularities in the beds, converting the rivers into rapid running, shallow water courses with a shifting sandy bottom. Very few Louisiana fish are adapted to life in such a stream and are driven out when their hiding places, feeding and spawning grounds are filled up by sand. If fine clays are also washed into the rivers they remain in suspension for longer distances down the stream and, by excluding the sunlight, most of the plant life and phytoplankton are destroyed. This prevents the development of the microfauna which are the most important source of food supply for young fish.

The effect of the gravel washing is, therefore, to reduce the normal food supply of the fish, to coat the eggs preventing their development, and to make the water so muddy that game fish lose their gamy qualities. The solution is simple for the "washed gravel" problem because in most cases it is only necessary to construct earthen dykes to separate the pits from the streams and so keep the clays and sand out of the river courses.

POLLUTION BY MISCELLANEOUS INDUSTRIAL WASTES

Alcohol plants, which make grain alcohol from molasses, discharge their wash into the neighboring streams. As these wastes resemble sugar mill refuse they can be purified rapidly and the microcrustaceae and mosquito larvae developing increase the food of Gambusia minnows. As a result these become exceptionally abundant. Under normal conditions aquatic life in such streams is benefited by the increased food supply.

Cotton seed oil refineries discharge wastes rich in oil and organic matter into the streams. This pollution could be remedied by discharging their refuse into the Mississippi, or by fermentation in settling ponds and discharging at high water.

CITY SEWERAGE

Pollution from city sewage has never become a serious problem in Louisiana from the fisheries standpoint. City drainage which includes trade wastes, oil drippings and garage wastes cause more concern than city sewage especially when storm periods follow drouths. During severe rain storms much drainage water from New Orleans is pumped

into Lake Pontchartrain. Currents of drainage water traveling from east to west along the shore drive away all fish, shrimp, crabs and motile food organisms. Because of the absence of this food supply the shore loving fishes and crabs are no longer caught in any abundance in the lake adjacent to New Orleans.

In order to find a solution of this difficulty it will be necessary to enlarge the drainage canals into Lake Borgne or run culverts out into Lake Pontchartrain, a mile from shore.

NATURAL POLLUTION

Several cases of natural pollution have been observed. During wet years our swamps and marshes have served as natural fish hatcheries. In subsequent dry years these fish are concentrated in much smaller volumes of water.

The oxygen supply is maintained there by the life action of microscopic plants, but in the lack of sunlight at night and during cloudy days these plants cease activity, then fish exhaust the oxygen in the waters and a wholesale slaughter follows. Gizzard shad, buffalo fish, paddlefish, fresh water sheepshead, game fish and catfish die, although gars, bowfin and top minnows survive 100 per cent.

The decay of blue green algae, by releasing highly nitrogenous substances poisonous to animal life, sometimes causes complete extermination of all animal organism in areas of lakes and ponds.

Serious cases of pollution are due to the after effects of forest and grass fires when followed by a rainfall sufficient to carry potash and other mineral constituents of the ashes into streams at times when there is little water flowing.

CONCLUSIONS

The studies herein outlined have shown the necessity of further research into pollution. They have shown that in Louisiana we must consider water a great natural resource that needs the protection of our conservationists. The great destruction of aquatic and other wild life during the drouth of 1924 and 1925 and the present scarcity resulting therefrom has done more than anything else to bring us to this realization. With a knowledge gained by study of the normal ecology of our aquatic habitats, and with a better knowledge of corrective measures, Louisiana is in a position to enter a period of constructive development of her aquatic resources, without placing a burden upon her industries.

SOME FEATURES OF THE STREAM SURVEY UNDERTAKEN IN NEW YORK STATE

By Emmeline Moore

New York State Conservation Commission

Stream surveys are growing in popularity as the essential means and method of developing an intelligent, consistent and rational policy for the distribution of the fish hatchery output. A dozen or more surveys are now under way in the various states and Canada. Such activity is significant. It represents one phase of the economic pressure which the modern demands in sport, recreation and fish conservation are directing upon the Department of Fish and Game. The mandate through the survey is to secure the facts underlying a better utilization of streams and to organize this data for immediate, practical application in the field of fish culture. By surveys, however, more is accomplished than the promotion of better planting methods as important as that is. Of far greater import than the salvage of fish will be the value to fish culture of projecting the problems of propagation beyond the boundaries of the hatchery into the open waters, thus supplementing the science of artificial propagation with the science of natural propagation.

New York State initiated its survey program this summer by undertaking a study of the Genesee River system. It is the intention to cover by surveys eventually all the streams and lakes and fisheries waters of the State. Such studies have been long overdue in New York and they are made possible now only through the operation of the Conservation Fund, a fund accruing from fish and game licenses, appropriation from which for the first time became available this year.

In the State's initial project, the county which is most frequently the unit chosen for survey study has not been selected for we have found it practicable and I think more advantageous to enlarge considerably the area of operation by concentrating our efforts upon the more unified problems of a stream system. When the work is completed this autumn we shall have in our beginning attempt a "full length" study of all the streams in the Genesee watershed from the headwaters at the Pennsylvania state line to Lake Ontario, a coverage of 2,445 square miles of open agricultural lands and a stream mileage of about 3,200 miles.

To cover so extensive an area in the brief space of three summer months has necessitated a field party of considerable size. The personnel includes thirteen scientists drawn largely from the staff of Cornell University and operating under the direction of the Conservation Commission with the Investigator in Fish Culture in charge. The staff includes four professors of biology, two on whole time and two on part time during the summer, an ichthyologist, a chemist, an artist and six graduate students.

The chief objective in the New York survey is in line with that of other states where surveys have been undertaken by Departments of Fish and Game; i. e., the attainment of a more intelligent stocking policy. Similarly the character of the data sought is in agreement with the general needs as they have been emphasized in other surveys, the subjects including a first hand study of the stream, its character and condition, the temperature, the food supply, the fish population, pollutional conditions, etc., together with the classification of streams according to their capacity to absorb certain numbers and species of fish. We have thus followed the accepted form or standards developed elsewhere, stressing only certain features more strongly, as, for example, the studies on pollution and the fish population of the system.

The responsibility of evaluating the streams and formulating a suitable stocking policy has been in the hands largely of Dr. George C. Embody. Primarily his investigations have sought to determine for the stream the answers to the following two questions:

> "(1) What kinds of fishes are likely to find conditions suitable for reproduction, normal growth and escape from enemies?
>
> "(2) About how many shall be planted in order to utilize the water to its fullest extent?"

Dr. Embody's determination of the number of fish to be planted is based on somewhat arbitrary standards since the factors involved are too numerous and varied to permit more than tentative recommendations. As he states, "The values for the Genesee River system will range from a low of about 50, 3-inch fingerlings per mile in the case of a stream 2 ft. wide and showing poorest conditions of food and shelter to a high of 2,000 fingerlings per mile for a stream 20 ft. wide and showing best conditions of food and shelter."

The maps* are the topographic quadrangles of the watershed adapted to our purposes of record. They show certain details of the river system, as permanent or dry streams, spring runs, planting places, dams, pollution outfalls and so on. The sheet accompanying the map supplies additional information, as the mileage of each stream available for stocking, the species of fish suitable and the number per mile. The nomenclature used designating the unnamed streams simplifies the location of streams and facilitates the keeping of permanent records. These maps, of which there are five sections or tiers comprising the entire watershed, will be published in the report of the survey, and should assist in the adoption of more effective methods of fish planting.

As regards pollution we shall have a helpful interpretation of conditions as they exist throughout the river system. The chemist is constructing a profile which will trace the course of pollution and recovery in the streams of the system by determining the dissolved oxygen at points above and below all outfalls. The importance of determining the dissolved oxygen is universally appreciated and the correlating facts are perhaps better known to fish culturists than any other single factor. The data show in a very interesting manner as regards oxygen depletion the contrast between a rapid, riffly stream and a sluggish, unruffled body which except where supplied by plants or other sources must of necessity reoxygenate by slow absorption from the surrounding atmosphere. Hence we are impressed with the need in dealing with the vexed question of pollution of taking into account at all times a consideration of the character of the stream. The biologist and botanist have contributed additional information by establishing from among animal and plant life criteria of pollution based on visible evidences.

In the study of the fish population an effort has been made to secure representatives of the entire stream system together with a study of their food preferences and the conditions favoring their natural development. About 60 different species are represented. Nineteen species of food and game fish, 25 species of minnows, and 13 miscellaneous forms. Six of the species found are mud-eaters including 2 minnows (Pimephales promelas and P. notatus). Five of the minnows are excellent bait (blunt nose minnow,

*The maps and illustrations are not reproduced. A copy of the full report with illustrations will be distributed to Departments of Fish and Game of the different states and a copy deposited with the librarian of the American Fisheries Society.

golden shiner, spot tail, common shiner, horned chub). One of the mud-eating forms (P. promelas) has possibilities of fish cultural value.

The collection of minnow paintings shown here is the work of Ellen Edmonson. They are a feature of the survey work not because they are ornamental only, though they would attain distinction in any showing of fish pictures, but because they are frankly propagandist to aid in stimulating interest in the study of minnow life. A dry order of facts about minnows is not adapted for popular consumption. It is stimulating and it engages the imagination, for example, to point out that the typical brook-trout-stream minnow is the Pearl minnow sharing with the trout the coldest waters. And that another competitor with the trout, though in the less cold waters, is the red-sided minnow. It is important to know that the minnow associate of the smallmouth bass in the swift waters of the larger streams is the long-nosed dace, an algal eater in part and not a competitor with the bass. The beautiful satin fin is a tolerant form and a good aquarium minnow. The black nose dace, an ubiquitous minnow of the smaller tributaries, is one of the most tolerant of all the minnows occupying waters in clean streams or in heavily polluted ones. Other paintings in the collection will include the common shiner, one of the best of bait minnows; the blunt nose minnow, a minnow with fish cultural possibilities; and the sculpin, a trout spawn eater.

It is hoped that the work of illustrating the minnows will be carried over from year to year as the survey progresses, and that they may serve not only as a delight but a guide indicating the importance of wise conservation methods for the species that contributes to the food supply of other fishes or that compete with them through excessive reproduction.

Finally it seems superfluous to say that in our stream survey we have had to let many things go. So hurried a survey cannot be marked by as great thoroughness as is necessary for all future needs. It does serve to point out a new path to follow in the distribution of fish and helps to present the serious claims that our stream resources have upon the general attention.

Discussion.

MR. QUINN: May I ask Dr. Moore what is the size of the adult blacknose dace?

DR. EMMELINE MOORE: It is something under five inches, usually, al-

though they do attain a little larger size. It is a small minnow; none of these minnows are large.

MR. TITCOMB: Is that color present all the year?

DR. EMMELINE MOORE: It is a breeding color, and is present a good part of the summer.

MR. LAIRD: Dr. Moore has seen our place on Long Island. I would like to ask her whether she thinks it would be possible to raise some of these fish, or gold fish, to furnish winter feed for trout we store in our ponds?

DR. EMMELINE MOORE: We have felt that the fathead *(Pimephales promelas)*, which is one of the two species of fatheads we have in the Genesee River, is a good one to experiment on so far as artificial culture is concerned. Both species are algal and meat eaters, and non-competitive. Of course the goldfish are also largely plant eaters.

MR. LAIRD: They would not get any of the food that the trout would get, to any appreciable extent?

DR. EMMELINE MOORE: No. However, the fatheads and goldfish would probably not thrive in the trout temperatures—not in the coldest waters.

MR. LAIRD: Would they not winter under ice?

DR. EMMELINE MOORE: Yes, they would. I think the species of goldfish that winters over under the ice is the golden-eyed, which is not our common goldfish minnow.

MR. REEVES: In how high a temperature will these dace propagate?

DR. EMMELINE MOORE: The black nose propagate naturally at the warmer temperatures. They are the common dace in the warmer waters of our streams.

MR. REEVES: Our waters in Oklahoma attain a fairly high temperature in certain seasons. I was wondering how they would do in water of a temperature of 70 or above.

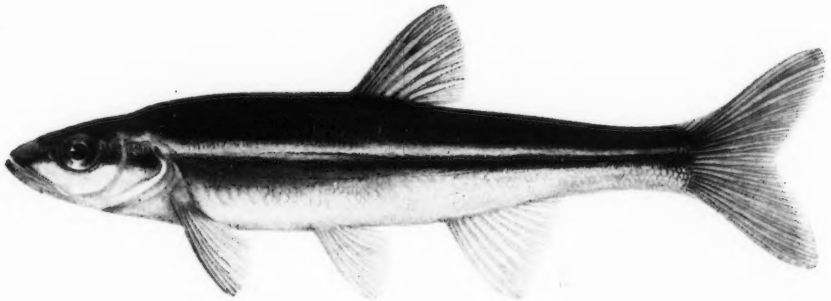
DR. EMMELINE MOORE: I should say that is a good range.

MR. TITCOMB: Do you recommend that pearl minnow for trout streams?

DR. EMMELINE MOORE: We have found it abundantly in trout streams, but the fact that it is there and that it accompanies trout in the very coldest stream runs is interesting. It is somewhat a competitor with trout, taking the insects that drop into the water as well as those that flourish within the stream. I think the introduction of that minnow into the series for study has been largely to enlist interest in the associates of the trout. Of course, as the minnow will follow along the trout stream lower down in the slightly warmer range, it should be a good minnow for an occasional meal for trout.

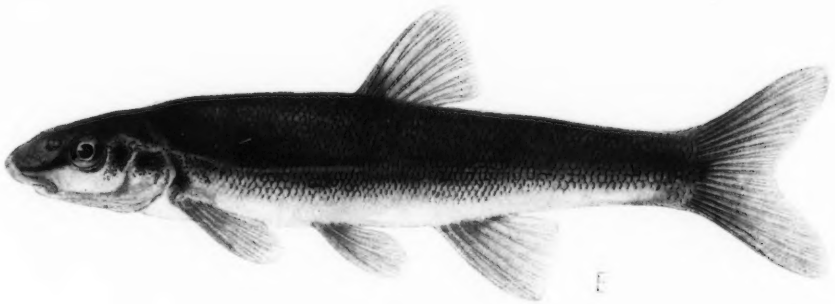
MR. TITCOMB: Does that minnow take a fly?

DR. EMMELINE MOORE: I think not; at least we have not discovered that it does. The horned dace takes a fly beautifully.



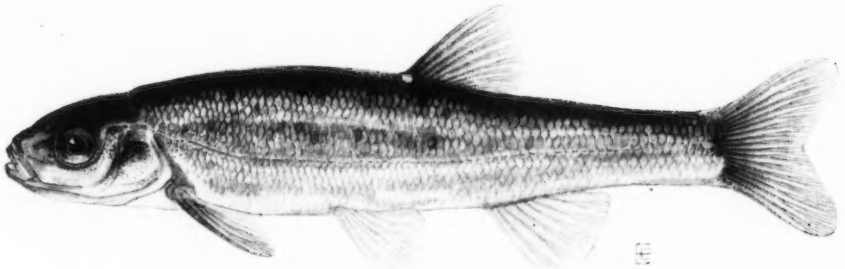
RED-SIDED DACE, *Clinostomus elongatus* (Kirtland)
Breeding colors from male about 3 inches long.

PLATE No. 1.



LONG-NOSED DACE, *Rhinichthys cataractae* (Cuvier and Valenciennes)
Breeding colors from male about 3 inches long.

PLATE No. 2.

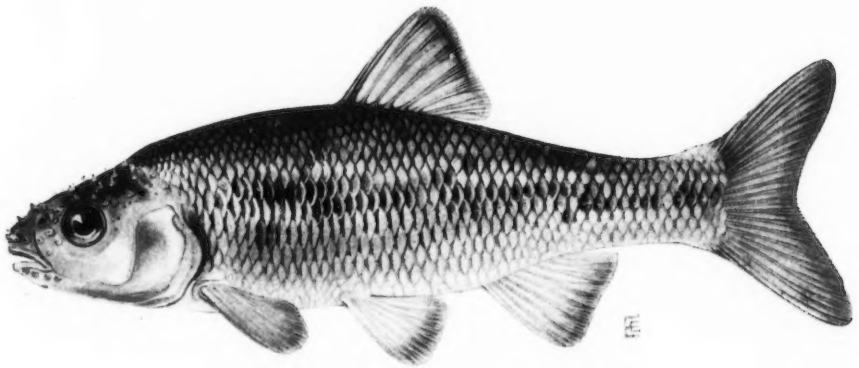


PEARL MINNOW, *Margariscus margarita* (Cope)
About 3 inches long.

PLATE No. 3.

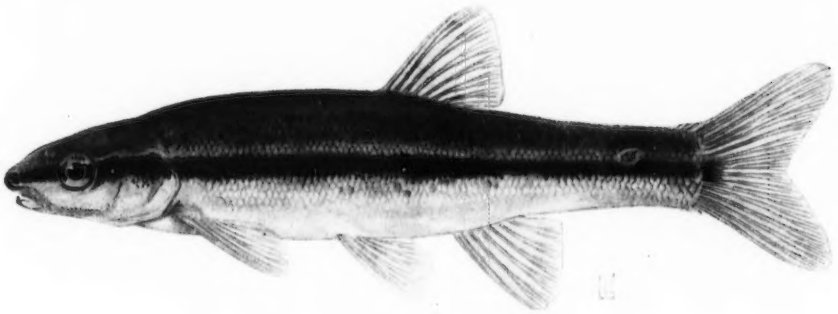
SATIN-FIN MINNOW, *Notropis whipplii* (Girard)
Breeding colors from male 4⅛ inches long.

PLATE No. 4.



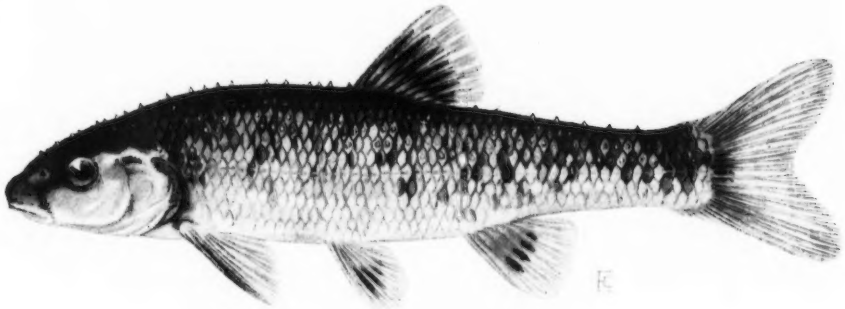
RED-FIN SHINER, *Notropis cornutus* (Mitchill)
Breeding colors from male 4⅜ inches long.

PLATE No. 5.



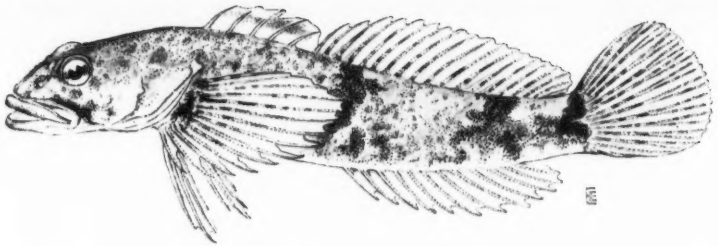
BLACK-NOSED DACE, *Rhinichthys atronasus* (Mitchill)
About 2¾ inches long.

PLATE No. 6.

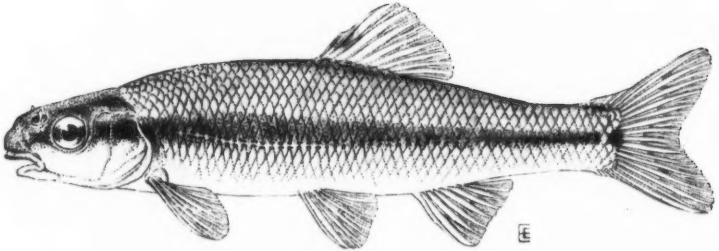


STONE-ROLLER MINNOW, *Campostoma anomalum* (Rafinesque)
Breeding colors from male 5⅛ inches long.

PLATE No. 7.



SCULPIN, *Cottus bairdii* Girard
From female 3 inches long.



BLUNT-NOSED MINNOW, *Hyborhynchus notatus* (Rafinesque)
3¼ inches long.

PLATE No. 8.

MR. LEACH: What about small goldfish for bass ponds?

DR. EMMELINE MOORE: That is the question Mr. Laird raised. It is a new idea to me. Mr. Quinn rather suggested it this morning in the discussion upon the rearing of goldfish for bass. It is an interesting proposition, and I consider it a very practical and advanced idea in the production of food for fish. Perhaps Mr. Hayford would have had some experience in relation to that.

PRESIDENT HAYFORD: In making a biological examination of the food at our hatchery last year, Dr. Embody suggested that we try goldfish in some of our bass ponds. We tried them in only one pond last year, and when we seined that pond off there were very few goldfish left. We put them in with the idea of having the larger bass feed upon them, thinking perhaps it would eliminate cannibalism, but it did not work out just as we expected. This year we had a lot of spring water there as well as pond water. We held these goldfish back from spawning until our little bass started to rise from the nests; then we planted the goldfish in these ponds. We put fifty pair of goldfish into each, and I do not believe there were 500 goldfish left in each one of the ponds when we drew them off. We had thirty-five pairs in pond 9 and fifty pairs in pond 10, and I do not believe we got fifty goldfish out of each one of these ponds. We have not carried on that experiment as far as we intend to. The only objection would seem to be that if you get the young goldfish to come around the same time as the young bass do, they eat up the food of the young bass. That seemed to be our objection last year in letting the two of them hatch at the same time. Until we got this new system of Daphnia started the bass did not go ahead; we had to seine them out and get them into ponds where there were no goldfish.

MR. CULLER: Some years ago, I think it was in 1908, we tried a similar experiment on the goldfish, but we introduced our goldfish at the same time we did the bass, in the spring of the year, and the result was that when we drew the bass pond in the fall we had more goldfish than we knew what to do with, some of them five to six inches long. Separating the goldfish from the bass was quite a job. The next season we held the goldfish in spring water until the bass had spawned, and then introduced them, and we were quite sucessful that time. We had not so many goldfish as the year before, but still more than we could handle. That was at the Wytheville, Virginia, station.

MR. LEACH: In any experiments of the Bureau of Fisheries we have to take into consideration the fact that conditions vary widely throughout the country. I have always thought that goldfish would serve a good purpose as food for the young bass, and for adults as well, at certain hatcheries. In northern states where the water is cold and we are not troubled with the growth of algae we find it necessary in introducing the goldfish to hold them in cold water and put them in late. At our hatchery at Lakeside, near Washington, the first year we had

to put the goldfish in the brood bass ponds; we did not have cold water, so we put 50 adults in a five acre pond. In July we transferred to the pond 3,000 bass about two and a half inches long. In the fall we took out 1,400 bass, the smallest about four and a half inches long, and 800 from seven to nine and three-quarters inches long. We also took out about a thousand small goldfish. Last year we were not so successful with our bass work. Our goldfish were placed in the same pond under the same conditions as in the previous year, but we did not introduce any small bass. We took out about 35,000 goldfish, which showed that the little bass the previous year must have consumed quite a number of goldfish. We have a ten acre pond at Lakeside, that is troubled with a growth of algae—a grey alga that comes up from the bottom and forms a scum on the surface of the water which causes the fish to smother. The first year we put about fifty adult goldfish in the pond, and did not have any trouble with the algal growth; the bass seemed to thrive on the goldfish and the goldfish thrived on the algae. But last year we did not stock it with goldfish, and had trouble with the growth of algae. We had the same condition this year. We had to remove our bass; it was practically a failure on account of the algae growth. Another year we will stock the pond heavily with goldfish and may not be troubled so much with the growth of algae. At a station like Warm Springs, Georgia, where there is considerable natural food for the young fish, such as Daphnia, it is hardly necessary to introduce goldfish. One year goldfish were introduced in the ponds at Warm Springs, the goldfish consumed all the Daphnia and the young bass starved. If you can introduce goldfish so they will prey upon the food that the bass will not consume, you will be ahead.

PRESIDENT HAYFORD: Mr. Leach's point, I think, is well taken. We have the blue-green alga in our ponds, and that is one of the reasons we introduced these larger goldfish. We had both the Spirogyra and Hydrodictyon there, and when you get them it plays havoc with the young bass. That, as I say, is one of the reasons why we started with these large goldfish, to help keep down the algae and find out if they could be made to serve other useful purposes.

MR. VIOSCA: With regard to the scum mentioned by Mr. Leach, did the fish struggle to the surface of the water before dying?

MR. LEACH: The alga rises higher and higher in the water until after a while it forms a scum. If it keeps on and the water is warm and the supply short, you will get a crust on the surface from one-half to three-quarters of an inch thick which puts a blanket over the surface of the pond. Moreover, the excess quantity of algae prevents wave action; you very seldom see a ripple on the pond, so that there is a deficiency of oxygen.

MR. VIOSCA: I think the fish are not smothered in that case, but die from decomposition of alga; the slow decomposition releases nitrogenous compounds in the water which directly poison all fish, without regard

to species, in the waters affected. Where there is oxygen depletion the fish which are in the same water all die.

MR. QUINN: Mr. Viosca suggests that the mortality among the fish in the case mentioned was due to the presence of nitrogenous compounds in the water as a result of the decay of vegetable matter. What effect would the carbon dioxide brought about by such a condition have upon the fish in our warm southern waters?

MR. VIOSCA: In cases which have come under my observation, in such waters the oxygen was in a supersaturated state. In other words there were free oxygen bubbles in the water.

MR. QUINN: But would it not scum over and prevent the carbon dioxide from escaping?

MR. VIOSCA: While this decomposition of certain plants is accompanied by the development of other species which, since they are living plants, are developing oxygen, this counteracting cycle of other plants is able to keep the oxygen in a supersaturated state during the entire period.

MR. CULLER: What would be Mr. Viosca's opinion as to the cause of the large loss of fish about two years age at Lake Bijeaux, about four miles from Pelba, Louisiana? Does he think that was due to the decomposition of the lilies or the water hyacinth?

MR. VIOSCA: I do not know that instance.

MR. CULLER: There was considerable loss of buffalo fish and different species of game fish in this Lake Bijeaux, and we attributed it to the decomposition of the water hyacinth. Tons and tons of buffalo fish, bass, crappie and sunfish were lost there. Lake Bijeaux is just south of Bayou Fordouche, and in high water it is supplied from this bayou. Lake Bijeaux was entirely covered with the water hyacinth.

MR. VIOSCA: I would like Mr. Culler to answer some questions before I can attempt to explain the situation. Was the bayou completely covered with the water hyacinths?

MR. CULLER: Absolutely, for miles.

MR. VIOSCA: Were there any heavy rains or cloudy weather just before the fish died?

MR. CULLER: No.

MR. VIOSCA: If it was in the spring and these water hyacinths had been killed by frost in the winter, the decomposition of the hyacinths could result in a natural pollution destructive to fish. Did the gars and minnows die?

MR. CULLER: Everything.

MR. VIOSCA: Then it would look to me more like a case of direct poisoning caused by unstable organic compounds, perhaps cyanogen compounds, acting very much in the same way as ptomaine poisoning would on human beings, except that in the case of the fish the absorption is probably through the gills.

MR. CULLER: There was another case. At the Grosse Tete they have been losing practically all the fish in that bayou during the spring rains. Is that attributable to the wastes from the sugar factory up there, or the chemicals used in washing out the vats? It is usually during the early winter that the loss occurs.

MR. VIOSCA: Sugar mill wastes are usually discharged in the fall, except in rare instances where they clean out the plant later. I do not know enough of the facts in this case to venture an opinion. Whenever excessive amounts of dead organic matter get into the streams, oxygen depletion occurs. I suggest that the water hyacinths may furnish the artificial pollution.

MR. CULLER: This waste is thrown off on to the land into a small area enclosed by a dyke, and when the heavy rains wash over the earthen vats the chemicals are carried into the bayou. Do you not think that is what causes the pollution and the death of the fish?

MR. VIOSCA: I do not see how any sugar mill can afford to throw away enough chemicals to pollute a stream. We have practically no chemical pollution in the state of Louisiana; with some exceptions, which I mentioned in my paper, it is generally organic waste.

MR. CULLER: To what would you attribute the loss of fish each year in that bayou?

MR. VIOSCA: I would have to see the bayou before I could give an opinion. It is probably explained by one of the causes of pollution mentioned in my paper or in the discussion.

MR. CULLER: We have a new hatchery on Bayou Plaquemines, about a mile and a half below the mouth of Bayou Grosse Tete, and the loss occurs there each year. The question in my mind is whether the water carrying this chemical will eventually reach the hatchery a mile and a half down stream at the pumping stations. We moved our hatchery from Pelba, Louisiana, to Bayou Plaquemines, about seven miles below the town of Plaquemines, on account of the pollution in the Atchafalaya River. Whenever we would have high water on the Ouachita, all the fish would leave the Atchafalaya and go south, and there would be no rough fish in the Ouachita for the commercial fishermen during that period of low water. When the river would start to fall, the catfish and buffalo fish would come back. During high water the pollution comes down the Ouachita from the southern Arkansas oil fields into the Red and from the Red into the Atchafalaya River. I remember that in one instance we set out 180 jars of buffalo fish eggs, and in twenty-four hours every one of them was dead, due to what we thought was the alkali, salt and possibly iron constituents in the water from the lower Arkansas oil fields.

MR. VIOSCA: I do not think the United States is rich enough to discharge a sufficient quantity of chemicals to pollute the lower Missis-

sippi River or the Atchafalaya to any appreciable extent. Were the swamps along the Atchafalaya River flooded during that period?

MR. CULLER: The water was high all over.

MR. VIOSCA: The fish which were formerly concentrated in the stream simply scattered over great expanses of flooded swamps. Besides, the currents flowing into these swamps are not favorable to our fish, which are really natives of still waters.

MR. CULLER: Well, there are roads from the main bayous back in, and everywhere the fishermen would set their brush lines there would be no fish caught. I think Mr. Tulian is familiar with that condition. It would be really interesting to us who had charge of the fish cultural work there to find out just what was responsible for the loss of these eggs.

MR. VIOSCA: The settling of that problem will have to be left until a later day. I think it shows the need of further investigation.

DR. EMMELINE MOORE: In our studies of pollution this summer we found this relation between the oxygen content and the carbon dioxide content; wherever the vegetation in the stream was excessive as a result of pollution—and following down the stream there will be an excessive production of plant life in such cases—and there consequently was an excessive decomposition of plant growth with an attending rise of carbon dioxide, together with a depleting of the oxygen supply, the condition became very bad and the fish were killed. So that when we use the minnow test for pollution in streams we have decided always to go as near as possible—as one of the points at which the experiment should be made—to some place in the stream a considerable distance below where things look bad, to the point where the oxygen supply is low and the carbon dioxide is high. It is the relation between the low oxygen supply and the high carbon dioxide content that is vicious.

MR. QUINN: Let me give a case in point that prompted the question I asked Mr. Viosca a while ago. In 1922 at the Montgomery Fishing and Shooting Club, seven miles out from Montgomery, practically all the fish in the pond there were lost. It was a pond of approximately seventy acres, and it was literally blanketed with American lotus and other water lilies, with broad leaves. The pond was about ten years old and contained a great deal of rapidly decaying vegetable matter. The average depth of the water would be something like five or six feet. When this loss took place we inquired into the matter and we came to the conclusion that the thing happened that you suggest, Dr. Moore. There was no wave action to whip in new oxygen, and the decaying of vegetable matter on the floor of the pond, giving up carbon dioxide which could not readily escape, was largely if not entirely the cause of the great mortality among the fish. This happened to all classes of fish, but the majority, of course, in the pond were bream and large-

mouthed bass. They were hauled out by the boat load every day during the summer.

I want to ask one question. This subject of pollution is of tremendous importance to us just now, because we are going to attempt a survey of our streams in Alabama, beginning next year. We have hundreds of saw mills along our small streams, and even on some larger ones, in which there has been splendid fishing. In the past all the sawdust resulting from the operations of the mills has been diverted into the streams. Most of this sawdust comes from the cutting of pine. Is there anyone present who can give me any information as to the effects of sawdust. Have there been any investigations as to what the results are to fish life when sawdust is placed in the streams? We are of the opinion that it has destroyed a large amount of fish in the Alabama streams. If it is destructive is it because or the resin or acids that may come from it? Is the destruction caused by the settling of the sawdust on the spawning beds? Is it a clogging of the gills while the sawdust is in suspension, or is it a combination of all three?

MR. HART: That is a very interesting subject in Virginia; we have the same conditions there. Our law provides that noxious substances shall not be placed in the streams of our state. These saw mill men claim that their sawdust does not hurt the fish. A discussion on this subject would be very useful to us when we are dealing with cases of this kind before the magistrates. We have master minds on this subject right here in this room, and I would like to see a very full discussion on it. It would be very useful to us in Virginia, and I am sure it would be useful to Mr. Quinn.

MR. REEVES: The same condition prevails in Oklahoma. We are very much interested in this discussion.

MR. HUNTER: On the Pacific coast most of the serious effects from sawdust come from the clogging of the gills. We have very strict laws now in regard to the disposal of sawdust, and we are having comparatively little trouble at the present time. In the past, however, it was a very serious condition.

MR. POLLOCK: I do not give my personal experience in this matter, but I have talked with some old fishermen in the Puget Sound district of Washington, and they tell me that back about twenty-five years ago there was an abundance of herring and smelt in the little estuaries and bays off Puget Sound. After the mills got started in these small waterways and some harbors some of the fishermen noticed that the herring were not very abundant, and they traced it at once to a condition produced by the sawdust and mill waste getting into the water. So that in 1915, or earlier, they revised the Fisheries Code and made the law with reference to that very strict indeed. It requires that every mill in the state that is anywhere near a stream or public water of any kind must provide for disposal of its sawdust and other waste so that it will not get into the stream. Our remedy is very short and sweet. We do

not tell them how to dispose of the waste; they must see that it does not get into the water. If it does, they have thirty days within which to do something, otherwise they can tell it to the judge. That is the remedy we have out there, and it has worked very well. In the last five or six years the larger mills have found that the sawdust and other waste is valuable as fuel. In the larger cities and even in some of the milling communities they are using this waste for the production of electricity—burning it up themselves. So our sawdust problem is not as difficult as it was in the past.

MR. LEACH: It has been our experience in the Bureau of Fisheries that sawdust is harmful to salmon and trout streams on account of its settling on the bottom and remaining for years. When the fish attempt to build nests it gets into their gills, and if they are lucky enough to be able to build the nest, the eggs are smothered. When the bass and other warm water fishes build nests it settles down into the mud and causes a condition which is not conducive to good nesting. It makes the mud more or less soft and spongy; it causes decomposition which interferes with nest building and drives the fish away from their nesting places. I doubt if there is enough acid or resin coming from the sawdust in trout streams to interfere with the trout in that way, but it does get into the gills and drives them away from their nests.

DR. EMMELINE MOORE: I would like to add just one further observation that I have made from the study of sawdust pollution and that is this: Wherever a good brook trout or brown trout stream has in its insect population the caddis flies, which attach to the surfaces of stones over which the current flows, there will be trouble with sawdust, because it will kill out practically all the caddis fly life. Certain species of the caddis fly have a habit of stretching little seines across and attaching them to the stones, to be utilized as little baskets for catching the almost microscopic insect life that comes down the current. Such caddis flies as depend, particularly in the larval stage, on the minute things that come over the stones, floating in the water, will be killed out by sawdust. I have seen a good trout stream in the Catskills spoiled by sawdust because it wiped out the caddis fly, which was important for the fish food.

MR. TITCOMB: Sawdust is cumulative from year to year until finally immense deposits of it are found in the still waters. Its decay is very slow, and in the process of decay it must exhaust the oxygen or cause a chemical condition which is unacceptable to the fish.

DR. EMMELINE MOORE: Wherever wood decays, and it is, as Mr. Titcomb says, a very slow process, it must absorb oxygen, because it is a biological process. Studies of leaf decay made by Dr. Davis of the United States Bureau of Fisheries, for instance, have shown that waters polluted by leaf decay are toxic to fish life. I concur in the comments that have been made regarding the effects of sawdust. I merely rose

to make that additional observation, which I think has not as yet been published anywhere. I add it simply to make one more fact in accumulating evidence that sawdust is obnoxious in a stream.

MR. TITCOMB: I have fought and bled on this subject of sawdust for a great number of years. The legislators or the people in opposition to any legislation against sawdust will tell you that you will find fish right at the point where the sawdust is discharging from the mill, and that is true. Similarly you will find fish right at the mouth of a sewage disposal plant. The ill effect does not seem to be so noticeable at the point where the sawdust is first discharged as it is farther down the stream. That is a principle which seems to obtain right through the whole pollution question.

MR. LECOMPTE: We have had a good deal of trouble with sawdust pollution in Maryland. Our law prohibits the placing or disposal of sawdust in any of our waters. Upon examination we have found that the fish were killed by the sawdust collecting in their gills. On numerous occasions we have had large rainbow trout, brook trout, bass, and practically all species of fish brought to us which had been found dead, floating in the water, in sections where a mill is being operated. It kills out all vegetable life, so that it affects the food supply of the fish, and it destroys them when it clogs in the gills.

MR. VIOSCA: With the depletion of our forests, sawdust has become a valuable product. Every electric light in Bogalusa, Louisiana, is made through the use of sawdust. Methods have also been devised for the making of wall board and insulating lumber out of sawdust. If we can show the lumber people that sawdust is valuable, our pollution problems from that source will soon cease. That is what we are trying to do in Louisiana—to show our people that in throwing away sawdust they are dumping money into our streams. It is a whole lot better to be able to approach the matter from that point of view than to make them pay a fine, with the chance that they will do the same thing the next day.

MR. HART: In our state the big mills can take care of their sawdust at profit to themselves; it is the small, travelling mills that give us the trouble. They go to one place, ruin the stream while operating two or three months, and then go somewhere else. I am mighty glad this discussion has taken place, because what I have learned from it will help us a great deal. It has been pointed out, as in Maryland, that the sawdust will kill the fish by getting in their gills. As Dr. Moore has pointed out, it covers the spawning grounds and kills animal life in the waters upon which the fish live.

MR. VIOSCA: We do not seem to have that trouble in Louisiana. The small mill can operate several years and the sawdust pile will be about an acre in area and from four to six or eight feet deep, so it is very easy to make them put it on the land.

MR. TULIAN: We did have trouble until the law required them to keep the sawdust away from the bank of the stream where it could

get into the water. We get right after them the minute the saw mills start there, and keep them from putting the stuff where it will run into the water. If necessary, we make them burn it. It is the small fellow that bothers us, too.

MR. LEACH: You make them burn it on the banks?

MR. TULIAN: Yes. Our law forbids putting it where it will ever get into the water.

MR. QUINN: I appreciate this very intelligent discussion on the pollution problem and I know that several points have been brought out that will be helpful to us in Alabama. I just want to say that it has been observed by persons who have crossed the bay here that in consequence of the storm which reached Mobile on Monday, thousands and thousands of pounds of fish may be seen dead in Mobile Bay. I have been asked why this high mortality should occur following the storm. I wonder if it is not the roiling of the bottom of the bay and the clogging of the gills with silt and sand.

MR. TULIAN: We had that same condition in Bayou Lafoudre after the storm of 1915. I even made the comment that the fish were drowned. Of course they were not; it was the churning up of the sand and debris in the water that killed the fish by the thousands there. I think probably the same condition has obtained here.

FORESTS IN RELATION TO FRESH WATER FISHES

By John W. Titcomb.

Superintendent, Connecticut State Board of Fisheries and Game.

The subject of this paper is rather broad and what I have to say upon it is based very largely upon my experience in New York, New England, and the Province of Quebec. It is treated more particularly with reference to waters which are or formerly were inhabited by some species of trout.

I feel almost apologetic in discussing this subject because it has been presented in various ways and on different occasions almost from the beginning of the settlement of this country by the white man.

Mr. Thaddeus Surber in his article entitled, "Methods used in restoring Minnesota Lakes and Streams," read before the Society at Denver last year, has made some radical statements relative to the effect of de-forestation upon the streams of Minnesota, which accord with my own experience. The statements which are true in regard to the effects of de-forestation upon the cold water fishes of this continent have more or less bearing also upon the warm water fishes. For this reason, I am hoping that the subject as treated will be of general interest to the members of the Society throughout the country.

In the report of the U. S. census, forest land includes "all land with natural or planted forest trees which produce, or later may produce, firewood or other forest products. It does not include brush land." This broad definition adopted by the Census Bureau seems to cover very well the conditions here in New England at the present time.

Let us first discuss the subject of the forest in relation to fish. When New England was covered with primeval forest it may be assumed that practically all of the streams were inhabited by brook trout and a large portion of the lakes and ponds were also inhabited by brook trout and many of them by lake trout.

At that time all of the rivers of New England flowing into the Atlantic Ocean were frequented by Atlantic salmon and this species even penetrated Lake Champlain, via the St. Lawrence and Richelieu Rivers. The salmon have disappeared from all of the streams except one or two in

Maine—a disappearance not due to overfishing. This discussion applies purely to streams in which the physical conditions have been changed by de-forestation. The trout have disappeared from a great many streams in every one of the New England States in which they formerly abounded. All of the trout species are extremely sensitive to high temperature of water and are classified as cold water fishes in contradistinction to the bass, perch, pickerel, bullheads and other warm water fishes of New England. A great many of the latter will live and grow in cool water, but their rate of growth is slow and it often happens that waters which have become a trifle warm for trout are not entirely satisfactory for these so-called warm water species. A large percentage of the ponds now inhabited by bass and pickerel were once the habitat of trout.

Many of the streams which once were teeming with trout now have a range of temperature during the warm summer days varying from an extreme low early in the morning of 60 degrees or 70 degrees to a high, running from 80 degrees to 90 degrees. A trout may occasionally be found in such a stream but usually in a shady hole where there is more or less seepage of spring water, or at the mouths of small tributary streams having a much lower and more even temperature. Even in the State of Maine many streams near the coast which formerly maintained trout no longer support them because the trout cannot live in the high temperature of water prevailing in the summer time. What has been said about the streams of Maine may be applied with equal force to the streams of the State of New York.

Pollution is only a secondary cause for the disappearance of these cold water fishes. The salmon could not return to such streams as the Connecticut or Merrimac Rivers even if the waters were purified from their present polluted conditions. Deforestation has so changed physical conditions that the waters are not congenial to them.

The conditions which I have stated are not new. Physical changes in streams, due to "denudation of forests" have been referred to by fish conservationists for the past sixty years. Thompson, in his invaluable "History of Vermont" published in 1842, says: "It is a common remark that the streams have diminished very much in size since the country began to be cleared and settled.... Before the country was cleared, the whole surface of the ground was deeply covered with leaves, limbs, and logs,

and the channels of all the smaller streams were much obstructed by the same. The consequence was that, when the snows dissolved in the spring, or the rains fell in the summer, the waters were retained among the leaves, or retarded by the other obstructions, so as to pass off slowly, and the streams were kept up, nearly uniform as to size, during the whole year. But since the country has become settled, and the obstructions, which retarded the water, removed by freshets when the snows melt or the rains fall, the waters run off from the surface of the ground quickly, the streams are raised suddenly, run rapidly, and soon subside. In consequence of the water being thus carried off more rapidly, the streams would be smaller than formerly during a considerable part of the year, even though the quantity of water be the same. It is a well-known fact that the freshets in Vermont are more sudden and violent than when the country was new".

When Mr. Thompson wrote this he apparently did not have in mind the changes in water temperatures resulting from the conditions he has so well described and it was written without thought of the devastating effect upon fish life which, a quarter of a century later, caused the New England States to take an interest in the artificial propagation of trout and salmon. After nearly fifty years of fish culture it became generally recognized that it is futile to attempt to restore the native species to waters from which they have disappeared—not because of overfishing, but because of physical changes in their habitat, originating in the cutting of the forests.

During the past few years, I have had occasion to visit a number of preserves in New York, New Hampshire, Vermont and Canada, where the owners were complaining about the poor trout fishing or wanted to improve it. In every instance the problem was one of high summer temperature, directly or indirectly due to deforestation and in most, but not all instances, deforestation was followed by fires. In one instance, beavers had finished the job of raising the water temperature by flooding a shaded stream and exposing to evaporation a large area of the main source of water supply to a lake. In the Province of Quebec, Canada, the preserve usually consists of numerous lakes on which a club leases fishing rights of the Government. The stumpage is sold to lumbermen. The preserve is fished in the summer. The lumbermen work in the winter. They

leave a fringe of trees along the portages and around the lakes but skin the rest of it. After a time the lakes teem with chubs, suckers, minnows, etc., and trout are few. Warm water favors reproduction of the inferior species formerly in normal abundance as food for trout, but which are now their competitors and occupy the shallower shore areas which, previous to deforestation, maintained a low temperature through seepage of water from the forest floor. The trout are driven to limited areas of cool water, their spawning beds are ruined by fluctuating temperatures or the deposited eggs are eaten by the increasing hordes of inferior species.

In a recent survey of streams in certain counties in Connecticut a most striking instance of the effects of shade on the banks of a small brook was noted where the temperature of the stream increased 10 degrees in a half mile of open meadowland in which all brush had been removed. The stream was exposed to the direct action of the sun, which resulted in a marked increase in temperature.

We must not only protect the sources of streams in order to maintain a congenial temperature for the fish most suitable for them, but we must encourage shade along the banks throughout the entire course of the stream. An exaggerated sense of orderliness on the part of farmers who are encouraged by the Farm Bureau agents in this matter (if I am not correct I am ready to stand corrected in this statement), indirectly aided by the reduction in the volume of water, is the main reason for the decline of many trout streams located in the agricultural districts, due to marked temperature fluctuations. Every person through whose land a trout stream flows should consider not only his personal convenience, but the value of the stream to his neighbors below him, and realize that if he deprives the stream of the natural fringe of shade—be it nothing more than alders,—he is adversely affecting the productive value of the stream on his neighbors' land as well as reducing its normal volume of flow.

The clearing of swamp land at the head of, or adjacent to a stream may result in the drying up of springs which are their main source of water supply. The work of one man, clearing a comparatively few acres, may prove disastrous to a stream in which many other land owners are vitally interested.

Next to water temperature, as affected by deforestation,

reduced volume of flow is responsible for the depletion of fish in many of these streams, or the total destruction of their value as fish producing waters.

I realize that when I begin to discuss the question of volume of flow or the natural run-off of water from a given water-shed, I run into a dispute between two schools of engineering, one of which maintains that the total run-off is not affected by deforestation, while the other school maintains that deforestation seriously affects it. Certainly it cannot be disputed by even the engineers who specialize in the study of this question that, whether the total run-off from a given water-shed which has been deforested is equal to that which prevailed before deforestation, we do not get the even flow of former days. Water will run off a slate roof much more rapidly than from a thatched roof. Under conditions of deforestation we are subjected to tremendous freshets. As the result of the removal over extensive areas of the water absorbing surface, which in a forest may be compared to a sponge, a heavy rainfall is immediately carried off through numerous drainage ditches, or is absorbed in sandy regions and so is of little permanent benefit. It often results in a lower water table, thus reducing the area and the depth of many lakes. The reduction in level in shallow lakes has the immediate effect of destroying the bulk of aquatic plant life so necessary for the growth of fish food for young fish. It also results in the destruction of the natural spawning beds of the nest building fishes and tends to produce overcrowding by reduction of area. It tends to produce a roily condition of the water, washing out the natural stream beds by irregular torrential flow and carrying away many elements which tend to build up the food and environment of the fish. This rapid disposal of the water tends to the drying up of streams during the season when there is little rainfall. In this way streams which formerly had a sufficient supply of water have now become reduced in flow or dry during the summer, with the inevitable increase in temperature.

Deforestation where tree trunks, brush, limbs, bark and stumps have been dumped into the stream or its headwaters tends to increase the amount of organic acids in the stream which in turn have considerable influence upon fish life.

The least valuable of all water from a fisherman's viewpoint is the small, swift, warm water brook. Such a brook

is very often dry in the summer, but there are a great many that maintain a permanent flow. Even in these it may be said that their small size makes them unsuitable for black bass, the high summer temperature renders them useless for trout, and the swift water unfits them for perch, sunfish and bullheads.

I realize that I will excite the criticism of some anglers—particularly the bass enthusiasts—because I have so frequently referred to trout, but unlike the trout, the basses are not natives of New England nor of many other parts of the United States and Canada. By introduction they have become a valuable addition to our fish population when substituted for trout in waters where trout could no longer find a congenial habitat. However, I know of no species the eggs of which are more susceptible to temperature fluctuations than those of both the large and smallmouth black bass.

Forest fires affect the streams not only by depleting the shade and removing the humus or sponge-absorbing qualities which have already been decreased under deforestation, but have another adverse effect upon the stream by increasing the alkaline content of the water. In some instances, the potassium hydroxide—potash—which is in the wood ashes, is of sufficient amount to cause considerable damage over a period of years.

I have been discussing the effects of deforestation upon the smaller streams. These, in turn, create the larger streams, lakes and ponds, and the larger waters are thus adversely affected in the same manner as the smaller ones.

"Land skinning" as President Roosevelt termed deforestation is inevitably disastrous. An illustration of the way in which man's actions have interfered with the balance of nature in this respect has recently come to my own notice.

The Connecticut Commission which I represent has recently acquired the fishing rights on about 140 miles of our larger trout streams. Some of them are rated very high as brook trout streams. This summer, during the month of July, we had an unusual drought and very hot weather. It was at a time when we would naturally be distributing 4 inch fingerlings in order to relieve the congested conditions of the hatcheries. Fearing that the trout waters throughout the State would generally be too warm to receive trout hatched and reared in a temperature around 50 degrees we circularized all of the applicants with a

request that they take the temperature of the waters in which they were proposing to plant trout. The wardens throughout the State were also instructed to report water temperature. The results of our findings were rather startling in that we found that a large majority of the streams ranged in temperature from 70 degrees to 80 degrees with a large proportion of them about 75 degrees. The small feeders would range from 53 degrees to 60 degrees but there were comparatively few streams reported having these lower temperatures. Consequently, we did not dare to make any distribution until the drought was broken and cooler weather prevailed.

Such an early drought is rather unusual in Connecticut and it was rather surprising to have only one report where trout were found dying in the brook. But it emphasizes the importance of taking proper precautions and avoiding the planting of trout while such conditions exist.

Some of my audience or those who read of this Connecticut experience will bring up the matter of substituting the brown trout for the fontinalis but that is an entirely different subject to be more properly discussed under another heading.

I maintain, therefore, in virtue of my own experience, that the maximum production of waters for cold water fishes such as trout is limited to the areas which will afford them shelter during periods of extreme drought and high temperatures. I have already mentioned the fact that on many large streams, where the water temperature ranges during such periods from 70 degrees to 80 degrees, the trout inhabiting such streams early in the seasons will be found during the drought period in spring holes, in the tributary feeders and at the mouths of tributary feeders. We cannot expect to have in these large, attractive looking streams the fishing of the period when the banks were shaded and the water-sheds were protected by forests, no matter how much stocking we do. By keeping the feeders stocked and guarding against over-stocking, there will always be some fishing in the main streams. We can increase the fishing in the main streams by planting adult trout very early in the spring with the expectation that a large proportion of them will be caught and that the balance will find the spring holes and tributary streams to carry them through drought periods.

Our duty is to take advantage of the knowledge gained

by experience and view from all angles the economic value of reforesting our unproductive lands. Let us make a careful and patient study of Nature's methods and adapt ourselves to them instead of trying to impose our own. The reforestation of waste lands will make possible the restoration of trout to some of the streams from which they have disappeared. It will render more favorable the habitat of trout and other desirable species of fish in many waters where under present conditions it is difficult to maintain the supply even by intensive stocking.

SYMPOSIUM ON FISH CULTURE

MR. TITCOMB (presiding): The suggestion has been made that we take up the subject of Trout first and confine ourselves to any one topic relating to trout before we branch off to some other phase of fish culture. When we begin to talk here we are apt to swing from one line of thought to another and to cover too much ground to get what we want.

To lead off the discussion, I am going to refer you first to an experiment we made this summer in feeding trout. Some of you who attended the meeting at Denver last year, had the opportunity of observing that the western commercial trout breeders use steam cooked food entirely, whereas in the east nearly everybody uses raw food. A hatchery seventeen miles from Denver which carried the most trout was surprisingly clean. The pools, one after another, covering a large territory, were very much crowded with trout, as we would think in the east, yet they were all clean. The night watchman did the cooking, and steamed about 700 pounds every night, largely of the lungs of animals.

I travelled with Mr. Frantz, whom you heard tell about feeding beans, and saw his methods of steam cooking the beans. As a result of my observations there we decided to experiment this summer with steam cooked food and with beans. Frantz used what he called the Mexican pinto bean. We got an ordinary small white bean, some lima beans and some peas, what are called seconds. We obtained them from a seed grower who did not consider them suitable for seed, although they were perfectly all right for anyone who wanted to cook a pot of baked beans. I issued an order to the hatchery foreman to use nine sets of troughs in the hatchery containing the progeny of eggs shipped from one commercial hatchery. I wanted the experiment tried with the one lot of trout. The instructions were to feed as follows: eight troughs, cooked beans and cooked meat mixed; eight troughs, cooked meat; eight troughs, raw meat; eight troughs, raw meat and cooked beans, using cod liver oil with all the food; four troughs, fed as our general run of hatchery fish, weighing and counting before beginning the experiment, leaving 1,800 trout to each trough, feeding each lot four times per day, but other than as to the mixture feeding them the same as the other fish. Instructions were given that no change in this

diet or methods should be made without consultation with the superintendent or field supervisor.

Just before I left I asked Mr. Cobb, our field supervisor, to report on the results of that experiment. He was much surprised to find that the foreman had been rather careless in that he had not kept an accurate count of the mortality—where he found only one or two dead fish in the trough, so that this experiment is not what the scientist would call an accurate one; but in a general way the results seem worth while. I shall carry it on again next year more thoroughly, perhaps having a better educated man devote his entire time to the experiment. The beans constituted about twenty-five per cent of the bulk of the food; the other three-quarters was the cooked food. When we cooked the food we used the trimmings that were taken off from the raw food that was put through the cutter and added that to the hearts and lungs, which were cooked whole. A pressure steam boiler was used. For the steam cooker, a tank made of boiler iron with a cover that could be clamped on it was used. The boiler is about two and a half feet in diameter and two and a half feet deep. We put a grating in the bottom so that the liquids would collect underneath the solids.

With four lots set aside for this experiment, occupying eight troughs to each lot, there were four control troughs left which were fed with the same food as was supplied to the fish throughout the hatchery.

No. 1 was fed cooked meat with 25 per cent cooked beans.

No. 2 was fed all cooked meat consisting of sheep liver, hearts and lungs.

No. 3. was fed all raw meat consisting of hearts and livers.

No. 4 was fed raw meat consisting of hearts and liver with 25 per cent cooked beans.

No. 5 had, as stated above, the feed used in the general run of feeding which consisted of beef hearts, beef livers and sheep plucks, with a mixture, part of the time, of a small quantity of beans.

The lungs and trimmings from the hearts and plucks were cooked under pressure. As to number in a trough, time and manner of feeding, and cleaning of troughs, it was intended to conform as nearly as possible to the manner in which all other fish were cared for. In tables for comparison, No. 5 is in all cases where the entire lot is

shown, multiplied by two as it contained only one-half as many troughs.

From the table No. 2 made the greatest gain, with 4, 5 and 3 following very closely together when the weight at beginning is considered. No. 1 fell behind in general appearance and condition from the first and were in poor condition at the end of the period.

Cooked meat made the best showing of any, while cooked meat and beans combined made the poorest. Raw meat and beans followed closely after cooked meat and is very close to those fed on combined cooked and raw meat with a small amount of beans.

From observation it would appear that when cooked meat and beans were ground together they formed compact particles in which both were mixed and that they were of necessity taken together by the fish. When raw meat and beans were ground together the mixture was not compact and there is a possibility that the meat could be taken without the beans if the fish so desired.

It would be interesting to learn just what portion of the beans was consumed when mixed with raw meat and also what portion of beans consumed was properly digested, but this is a job for a scientist.

Reduced to a basis of 1,000 trout, the actual gain per 1,000 fish was closely as follows:

No. 1, 10 pounds, 12 ounces
No. 2, 13 pounds, 10 ounces
No. 3, 12 pounds, 8 ounces
No. 4, 12 pounds, 10 ounces
No. 5, 12 pounds, 9 ounces

In percentage of gain the results would be about as follows:

No. 1, 187%
No. 2, 235%
No. 3, 238%
No. 4, 283%
No. 5, 224%

It will be noted that in the order of percentage of gain the various lots group as follows: 4-3-2-5-1, while in actual gain per 1,000 they are 2-4-5-3-1. The results of all except the mixture of cooked food and beans are so nearly alike, when all is considered, that there is little choice in

them. The good results of cooked meat would indicate that in No. 1 it was not the meat which was at fault.

In feeding cooked meat the tissues do not foul the troughs as is the case where raw meat is used, which might be taken to indicate that they were digested when fed in a cooked state, or that they were in a condition to pass easily through the screens after the digestible parts were utilized by the fish. The growth made by the fish fed entirely on cooked meat would indicate that roughage especially was made more digestible and that a gain was made in this way, while the lesser labor in cleaning ponds and troughs will well repay for the labor of cooking as applied to plucks and to trimmings from livers and hearts.

It might be suggested that the cooking of the meat would kill the germs, but Dr. Moore thinks we ought to have some raw food.

This experiment began on June 5th. I have had a table prepared showing the weight of these lots at intervals from the commencement of the experiment down to the second of September.

	June 5 Weight of Lot	July 15 Weight of Lot	July 15 Weight of 2,400 Removed
No. 1	83 lbs.	121 lbs. 8 oz.	17 lbs. 6 oz.
No. 2	83 lbs.	132 lbs. 7 oz.	24 lbs.
No. 3	75 lbs. 6 oz.	132 lbs. 10 oz.	24 lbs. 8 oz.
No. 4	66 lbs. 6 oz.	114 lbs. 1 oz.	23 lbs. 10 oz.
No. 5	80 lbs. 8 oz.	135 lbs. 8 oz.	22 lbs. 4 oz.

	Aug. 7 Weight of 2,400 Removed	Aug. 15 Weight of 9,600	Sept. 2 Weight of 8,00(
No. 1	24 lbs. 4 oz.	132 lbs. 14 oz.	131 lbs. 10 oz.
No. 2	28 lbs. 6 oz.	148 lbs. 8 oz.	154 lbs. 15 oz.
No. 3	29 lbs. 15 oz.	138 lbs. 4 oz.	142 lbs.
No. 4	28 lbs.	115 lbs. 4 oz.	143 lbs. 5 oz.
No. 5	26 lbs.	144 lbs.	146 lbs. 2 oz.

I do not know that these figures will mean much to you except as you read them and study them. But in a general way we think that the steam cooked food is a good thing. While our No. 1 lot, the twenty-five per cent beans, did not do nearly as well as the others, we are not entirely satisfied that there is no merit in beans. Mr. Frantz had

good results with his rainbow trout. We used the cooked beans more or less with raw food, and those fish did well.

I will now throw this topic open for discussion, purely from the food standpoint. I believe that the cooked food is economical. You save all the blood and all the fibre; there is absolutely no waste except the fat. When the hearts are steamed in with the other stuff it dries out the fat. When we drain the boiler or the steamer we have arranged to cool the liquid so that the fat rises to the surface. You can take from the liquid before it goes into the sewer a cake of clean white grease, which is good material for the making of soap and that sort of thing. We have not tried to save it in marketable quantities, but I believe that is the proper thing to do where extensive feeding is carried on.

Discussion.

DR. EMMELINE MOORE: Has the Chairman (Mr. Titcomb) experienced any difficulty in getting the fish to take this cooked food?

MR. TITCOMB (Chairman): None whatever.

MR. FOSTER: I have been cooking sheep's livers for the smaller fingerlings, grating it and then adding to this grated mass, which as you know is rather dry in substance, either cod liver oil or yeast—cod liver oil once a day and the dissolved yeast once a day. Then instead of using beans I have used the water in which the liver was cooked for the liquid in making the mush, either of whole ground wheat, or of oat meal. I have been feeding rolled oats at about $56 a ton f. o. b. hatchery, and I really like the rolled oats as well as any cereal which I feed. I believe that the cooked meat is most excellent diet, and I have fed it clear, without mixing it with the cereal until the fish attain a length of about four and a half inches.

THE CHAIRMAN: You did not have any control experiments to observe the results of that feeding?

MR. FOSTER: No, we did not have an opportunity this year to do that.

THE CHAIRMAN: You simply cook it?

MR. FOSTER: Cook it in the ordinary mush cooker—boil it twenty minutes.

THE CHAIRMAN: Boil the meat?

MR. FOSTER: Yes, then remove the meat and add cereal to the water which is already in the cooker.

MR. LAIRD: Do you cook your meat whole, or do you grind it before you cook it?

MR. FOSTER: Cook it whole and grate it afterwards.

THE CHAIRMAN: You use entirely sheep's liver?

MR. FOSTER: Yes.

MR. LEACH: Mr. Chairman, the pressure cooker you spoke about—is that actually cooked under pressure?

THE CHAIRMAN: Yes.

MR. LEACH: Mr. Frantz spoke about his being a pressure cooker, and it is nothing but an open kettle.

THE CHAIRMAN: He covers it and clamps the cover down.

MR. LEACH: It looked like a thirty gallon iron kettle. I do not see how you could clamp the cover down hard enough to keep the steam in.

THE CHAIRMAN: They have a gasket around the top; the cover is held tightly in place by five or six thumb screws.

MR. LEACH: Dr. Davis claims that the small fish will not digest the starch in whole wheat flour, or starch of any kind for that matter; it is practically useless to feed starch to small fish. It is doubtful as to whether there is any benefit in feeding large fish starch. The experiments have not gone far enough to justify a conclusion as to what part mush really plays in the diet of the larger fish, but I am rather doubtful whether it pays to feed very much of it to the small fish. So we expect to add just enough to the flour to form a binder for the food so that it will not scatter too much when we put it in the troughs for the fish which are three to four inches in length.

THE CHAIRMAN: The flour is to act as a binder, you say, to keep the other food together?

MR. LEACH: Just to absorb the liquor and to bind the other foods together—make it a little easier to feed.

THE CHAIRMAN: Will you be able to conduct control experiments?

MR. LEACH: We are going to conduct control experiments at four different hatcheries by feeding small fish flour mixed with the meat at the rate of possibly twenty-five per cent flour. We will also feed the straight meat, and will weigh and count the fish, keeping track of losses, so that we will know each month the results of the different experiments. The other fish will be fed a straight raw meat diet. Cooking the food has certain advantages. It keeps the troughs cleaner, and there is not apt to be so much disease, especially gill disease. Moreover, this kind of food does very little harm if a surplus remains in the trough. On the other hand if raw food remains in the trough it is apt to cause gill disease trouble, especially if the troughs are not kept very clean.

MR. LAIRD: I would like to ask Mr. Foster if he got his fish to four inches with the cereal food and the meat any quicker than he would have done if he had fed the regular meat diet?

MR. FOSTER: I fed no cereal food until the fish had attained a length of four and a half inches.

MR. QUINN: May I ask Mr. Leach whether he will apply the feeding he speaks of to bass as well as trout hatcheries?

MR. LEACH: No, trout only.

MR. QUINN: Have you had any experience in the feeding of cooked food to the bass or the bream?

MR. LEACH: No, I do not believe they would take it. With regard to the question of starch, if the wheat could be put in a sprouter and allowed to sprout, that might have a tendency to destroy the starch and thus to make it more digestible for the small fish.

MR. FOSTER: Mr. Leach is getting on dangerous ground, between the sprouting of grain and the pressure cooker.

MR. CULLER: When speaking of cooked food, do you understand it to mean liver?

THE CHAIRMAN: Liver, lights or lungs and hearts.

MR. CULLER: A majority of fish culturists mix water with their food, making a sloppy mixture, feed it with a spoon and immediately bring the spoon right back. By that time the water is so milky that the small fish cannot see the food. I have found that if you take the care and the time in feeding the beef heart with the feeder, you have very little trouble with gill disease.

THE CHAIRMAN: I think Mr. Culler is right; there is a tendency to use too much soup in feeding fish, much of which goes through the screens and is wasted. You do not get so much of that milky stuff with the cooked food.

MR. LEACH: We have a great deal of trouble in getting our fish culturists at the various stations to feed the fish properly. The method employed at our hatchery at Springfield, Utah, appeals to me, and I have had several of our hatcheries try the same method. They grind their food very fine, and of course no water is added. They place a small lump of food near the upper end of the trough and one near the middle, and let the fish break up the lumps.

THE CHAIRMAN: Would you do that with fry just rising to food?

MR. LEACH: Springville starts them that way. The little fellows tackle that food with a will, so that it is scattered about and the rest of them get it. Our Springfield superintendent has been very successful in raising his fish with little loss. But it all comes back to the human element; the man who feeds the fish carefully will get good results with almost any method that is used. In practically all our hatcheries we tell the men to feed the food with as little water as possible—just enough if feeding with the spoon to make it slide off the spoon. They are asked also not to agitate the water any more than is necessary; to put the food in the water, just skim the spoon along so that the food will slide off and the little fish will be able to take it up over the full width of the trough. Some of them seem to think they must put it in with their hands and churn up the water, but when they do that they wash out all the food elements, and the fish get very little out of it except possibly some consomme.

DR. EMMELINE MOORE: I would like to ask Mr. Leach if he thinks that a diet of cooked food entirely is adequate?

MR. LEACH: That is something I have not considered. It seems to me that raw food would naturally contain elements which would not be found in the cooked food. On the other hand, as I say, the commercial hatcheries that are feeding cooked food are getting such excellent results—if they are telling the truth about their losses—that the cooked food must be all right. Not only Frantz but some hatcheries in Michigan, and at one or two other points have been feeding the cooked food; their fish are in excellent condition, showing absolutely no trace of gill trouble. Moreover, their losses have been much below those at hatcheries where they have been feeding the raw food.

DR. EMMELINE MOORE: Do they use vitamins then? Do they use the cod liver oil?

MR. LEACH: Not at all places Most of the commercial hatcheries feed a straight cooked diet, something like Mr. Titcomb has been feeding. At some of our hatcheries where we feed the raw food we usually add cod liver oil, also iodine—although we do not add the iodine except where we have been troubled with gill disease or thyroid tumor. Cod liver oil seems to supply an element that is necessary to the fish.

MR. LAIRD: Reference has been made to placing lumps of food in the trough in one or two different places where the fish can get at them. I use that system, with a little modification. I take a piece of 8 square to the inch galvanized wire, bend it over two by four, thus making a hollow pocket. I set three small nails in the bottom of the trough and let that rest on the nails. The food is put in this in lumps, and it is so arranged that the fish can get something to eat all the time. When the food has all been eaten we put another bunch in.

MR. CULLER: Has anyone experimented with the feeding of cooked food right through to the adult fish and observed what effect it had on the egg production?

THE CHAIRMAN: All the Colorado commercial hatcheries use cooked food entirely.

MR. LAIRD: Do they buy their eggs or strip them?

THE CHAIRMAN: Well, they have eggs, and they sell some of them. I do not know to what extent they buy their eggs; I do not hear of their being in the market.

MR. CULLER: It would be interesting to know whether there is any difference in the quality of the eggs from the fish fed on raw foods as compared with eggs taken from fish that are reared on cooked food.

MR. SURBER: I have to quote ancient history again and give my experience of about thirteen or fourteen years ago. The use of mixed foods for the feeding of trout so completely disgusted me with that class of food that it led me to the determination that if I ever was in a position to do so I would entirely avoid its use. Since I have been superintendent of the Minnesota hatcheries it has not been used at all, either for the young fish or the adults.

THE CHAIRMAN: You mean the mush?

MR. SURBER: The mush, yes. I think you will remember the experiment carried on at White Sulphur Springs over a period of two or three years in that connection. I will point out one thing. Since we place a man on duty say early in the morning, with the help of another man up until dark, feeding six or eight times a day until the fish are three or four months old, we are getting better results than we ever got before, and the losses have been reduced to practically nothing. The St. Paul hatchery, I think, is a shining example of what can be accomplished in that manner. Prior to this past season, when this scheme was adopted, the losses there amounted to about twenty-five to thirty per cent, but up to the time that we had the disease break out early this summer our losses amounted to practically nothing. The same result has been achieved in our handling of the fish in our southern Minnesota hatchery at St. Peter, where the fish culturist has always fed from early in the morning practically until dark, until the fish reach a length of approximately three inches. He does all the feeding, and he does it slowly and carefully; he sees that the fish get no more than they immediately consume, and the result is that he has clean troughs by the time he has completed the one round of the hatchery. I think the bulk of the trouble lies in the carelessness with which fish are fed—not so much in the food itself. Careless feeding results in filthy troughs and permits the fish at the upper end of the troughs in all probability to gorge themselves at the expense of those toward the lower end.

THE CHAIRMAN: I do not think we can put too much emphasis upon the necessity for care in feeding, and for cleanliness; I am sure we all agree on that. We have not heard a word from Mr. Hayford, who is the great trout man of the country.

MR. HAYFORD: I will merely state what we tried to do this year. Dr. Davis came to the hatchery twice during the year, and we discussed different matters, particularly in reference to raising the small trout. We did not run a check to give us accurate information, but we do know this: that our trout did much better this year than they did last; that the losses among them are considerably less, and that the fish are an inch to an inch and a half longer than they were the previous year. As to the feeding, it was done in this way: As soon as they started to take food, we gave them finely ground beef liver. About the first week in February we switched to three feeds of beef liver a day and two feeds of thick sour milk. We stirred the sour milk, and we fed them practically every day, one feed of three per cent cod liver oil mixed into the liver. The easiest way to get that was to mix into a pail as best we could, then take it up and turn it into a big power grinder, which has a capacity of 800 pounds an hour, with a seven and a half horsepower motor behind it—grind it through about three times and in this way get it thoroughly mixed. We continued this feed right along until the trout

got to be four or five inches long, which would be about the middle of June or the first of July. We did use brewer's yeast, but I do not think it has been definitely determined yet whether we got any particular benefit from it. Dr. Davis' opinion is that he gets some results in the brook trout but he is not sure yet as to the results with the rainbow. After they get to be four inches long we switch them to sheep's plucks, consisting of the heart, liver and lungs; and—this will probably please Mr. Tulian—we add ten per cent of the shrimp bran that we buy from Louisiana. By putting this shrimp bran in we get two things—coloration and an avoidance of fin nibbling. In the ponds where we do not feed the shrimp bran they are inclined to chew one another up, as the boys call it.

The greatest problem we have had to contend with is the necessity for raising so many fish to a large size in order to satisfy the sportsmen, and to keep the fins and everything else perfect, because they do not like to catch fish with two ar three fins gone; they think he does not fight as much. We must get these fish up to the size that we put out this year, 251,000 fish fourteen inches long—not many fourteens, but a great many eights, tens and twelves.

THE CHAIRMAN: Two-year olds?

MR. HAYFORD: Yearlings and two-year olds. We can get seven and eight inch yearlings, but the general run is two years. Ever since we started putting the big fish out, they have forced a program on us of planting the fish above legal size. We have now had another pond built to raise an additional 200,000, and the turning out of these large fish involves a big problem, because it is going to take about 1,500 pounds of food per day. Our feed bill last year ran to something like $13,000, with an average of around 1,000 pounds a day.

We have tried small butterfish, which we believe are good in the spring of the year—I would not say throughout the winter months; we have also tried the different cereals that have been mentioned, but the combination we used this year has proved the most satisfactory of all; it has given us a much smaller loss and a greater growth. In that connection I think I figure a little differently from what a great many fish culturists do, because I set off the costs against the production. If I can get 100,000 eight inch fish to a certain value I do not pay any attention to the loss of fish; I work on the values. If I should lose two or three hundred or four hundred thousand small fish, I would not lose any sleep over it, because we start with enough little ones to get by with the big ones. Where you are planting small fish and you have got to get the count out, you possibly may run into some difficulties, because we find if we are not awfully careful we get that condition of roiling. We have water enough to clear them, but at the same time our object at the start is to get rid of the weak fish as quickly as possible and work on the strong ones. In fact we turn on a flow of water and drive the weaker ones against the screens to get rid of them.

MR. HUNTER: How much does it cost you to raise two-year fish to eight or nine inch size?

MR. HAYFORD: Down through our section the quotation for eight inch fish is from $200 to $225 a thousand. For the last two years we have been getting by on a cost of about sixty per cent. In other words, if they sold fish at $100 a thousand, the cost of putting them through would be about $60. In the case of a state proposition, when you figure the interest, upkeep of plant, and so forth, you are getting it down to facts and figures. On the basis of the results for the last ten years the proposition is paying a dividend of from seven to nine per cent on the trout work as a commercial enterprise. As a business proposition it would not work out that way, because a business man has interest and taxes to pay that we do not have to provide for.

MR. HUNTER: In the commercial trout farms in the West I understand they estimate the cost of raising the fish as from thirty-five to forty-five cents a pound. It takes from six to eight 9-inch fish, I would say, to weigh a pound.

MR. HAYFORD: Three 9's, four 8's, and two 11's.

MR. SURBER: What do you pay per pound for beef liver?

MR. HAYFORD: It runs from eight to nine cents a pound. We have pretty sharp comptition between the Swift and the Armour people, because each one has a plant within twenty-five miles of our hatchery and does a large business. In many cases the difference is only about three cents a hundred.

MR. SURBER: That is about what we pay in Minnesota.

MR. HUNTER: Your figures would amount to about five a fish—$200 a thousand.

MR. HAYFORD: Figure it at sixty per cent.

MR. HUNTER: You turn these fish into the stream for the fishermen to catch?

MR. HAYFORD: Yes.

MR. HUNTER: What is the bag limit in your state?

MR. HAYFORD: Fifteen.

MR. HUNTER: Is there any weekly limit?

MR. HAYFORD: No.

MR. HUNTER: How many fish may a fisherman catch during the season?

MR. HAYFORD: He may catch fifteen every day if he likes.

MR. HUNTER: What is the cost of his license?

MR. HAYFORD: $1.75.

MR. HUNTER: Is it a business proposition to turn these fish out at $1.75?

THE CHAIRMAN: Are we not getting a little off our subject?

MR. HUNTER: It is of interest, nevertheless.

THE CHAIRMAN: When a state has plenty of money and the angler

is willing to pay a license fee, you have to do a great many extravagant things. Mr. Surber speaks about the long hours that he feeds. May I ask Mr. Hayford how many hours his men feed during the day?

MR. HAYFORD: Nine hours. The first feeding is about seven o'clock in the morning. The last feed at night is a heavy one. We put in the troughs all we dare and they clean it up before dark. There is none left over; there is no waste.

THE CHAIRMAN: Are you quite sure that Dr. Davis' experiment with the yeast yielded better with the brook trout than with the rainbow?

MR. HAYFORD: That is my understanding. He could not get any results with the brook trout but he did get them with the rainbow.

MR. LEACH: He has only experimented with the rainbow in a small way. He expects to take that up next year.

THE CHAIRMAN: He did not get results with the brook trout, or did he?

MR. HAYFORD: As I understand it, Dr. Davis has not gone far enough in his experiments with the brook trout to be sure that the yeast is of value. But he is satisfied that the yeast is of value as food for the rainbow, although he has not as much proof yet as he wants in that regard.

THE CHAIRMAN: I understood he had given up the idea of using yeast on brook trout.

MR. HAYFORD: Yes, I think he has satisfied himself.

MR. FOSTER: I am satisfied that the yeast is of value where you have crystal in the kidneys, in the small fish.

THE CHAIRMAN: You mean with any species of trout?

MR. FOSTER: With the rainbow.

THE CHAIRMAN: It is rather interesting the way some of our methods have a tendency to revolve around in a circle. Twenty-five years ago all the eastern commercial hatcheries fed mush. They boiled red dog flour or some other coarse wheat, and then after it was cooled they stirred into it raw liver. I think every one of the hatcheries down on Cape Cod did that. We are now getting back to it, through the Bureau of Fisheries, and in a more scientific way; with the experiments that Dr. Davis is carrying on I assume he will know whether the mush has food value, and all that pertains to it. In the olden days they did not know, they simply thought they were saving the price of some liver.

MR. LEACH: It is a very difficult thing to try out mush on adult fish. It is an easy matter, however, to try it out with small fish. Two years ago we tried three lots of small fish at two different hatcheries. We counted the fish when they were about two inches in length;—we weighed them at the beginning of the experiment and every thirty days we checked up on weight and other particulars. Lot. No. 1 was fed a straight meat diet of about ten ounces a day. No. 2 was fed about six ounces of meat and four ounces of cooked mush consisting of whole wheat

ground fine—the whole wheat flour is cheaper than the red dog. Lot No. 3 was fed ten ounces of meat the same as the first lot, with four ounces of mush added. The experiments were conducted over a period of two months. The fish fed on the straight meat diet gained the most, sustained the smallest loss, and were the best fish all the way through. The ones fed on the meat and the mush at the rate of six ounces of meat and four of mush, showed the greatest loss and the smallest gain in weight, and those fed on ten ounces of meat and four ounces of mush did not gain as much as the ones fed on the straight meat diet. That is pretty conclusive evidence to me that brook trout do not gain anything when fed mush.

THE CHAIRMAN: Are you carrying out further observations and experiments in the feeding of mush to the brook trout?

MR. LEACH: We were trying that experiment only with the small fish, with a view to determining its effects upon fish of that size.

THE CHAIRMAN: What is your plan for next summer?

MR. LEACH: Our plan is to add sufficient flour to absorb the liquid after the food has been cooked. As I say, when it comes to feeding mush to the adult fish I doubt whether it has any real value except to act as a binder to the food. It is possible that in the feeding of lights and lungs the addition of mush has a binding effect and results in the fish having a better chance to get the meat.

MR. HAYFORD: In regard to the mixing in of the red dog flour, it would seem that the fish are inclined to take only the coarser particles, with the result that a lot of that fine stuff goes to the bottom. I am satisfied that it is a waste of money to buy bran to mix in with this food because, for one thing, it increases the cost of labor to get the stuff out of the ponds

THE CHAIRMAN: I quite agree with that.

MR. FOSTER: That is one reason why I like oatmeal better than flour; it is more glutinous.

THE CHAIRMAN: The problem you have, Mr. Foster, would be one of economy, would it not? Is the oatmeal cheaper than the meat?

MR. FOSTER: Yes, exactly.

THE CHAIRMAN: Have you kept a record so that you can tell whether the quantity of oatmeal and meat combined—in weight, for instance—is not more than you would feed if you were feeding meat alone?

MR. FOSTER: No records have been kept on that, Mr. Titcomb. The men who have been doing this work are novices, you might as well say, in the feeding of trout. I simply gauge the number of pounds of meat and the number of pounds of moisture—what I consider is the right number, the right quantity, and do the feeding at that rate—five pounds of meat, and five pounds of either the flour or the oatmeal, preferably the latter, for a thousand adult fish a day.

THE CHAIRMAN: I hope you will all understand that I am not a presiding officer to-night in the strict sense of the word. This is a symposium in which we all desire to participate, and I am trying to draw out some things. Mr. Leach says he does not think cooked food is desirable for adult trout, and yet in the face of that, every hatchery in Colorado is successfully raising adult trout and feeding cooked food entirely.

MR. LEACH: I would not give fifty cents a thousand for their eggs.

MR. LECOMPTE: Did not Frantz say he fed only the beans and no meat?

THE CHAIRMAN: No. Mr. Frantz was the only man who fed beans, but they are mixed with animal foods; the others all feed largely lungs.

MR. FOSTER: I want to line up with Mr. Leach on the question of feeding raw meat to the adult fish. When they are four and a half to five inches long I shift from the cooked meat to the raw meat for the larger sized fish.

THE CHAIRMAN: It is an interesting point. What I want to submit for your consideration is this: We do not want to take it for granted that because you get some poor eggs from a commercial dealer in Colorado, the feeding of cooked food to the adult trout is the cause of the poor eggs. They may be overfed, the same as may happen with the raw food. If you could at one of your hatcheries feed half your adult trout—the trout from which you are taking eggs—on raw food during a certain period, and the other half on cooked food, making notes of the results in eggs, we would have something definite about the effect on the eggs

MR. SURBER: You will recall that at White Sulphur Springs we carried on control experiments with our brood stock over a period of two years, both rainbows and brooks. Those were my early days in fish culture; I thought the fish should have every attention, and I proceeded, as many novices will, to over-feed one pond of brooks during the summer. Alongside that pond we were feeding a similar quantity of mixed food, mush and liver, to the same number of fish, of the same size. That fall the eggs we obtained from the fish which had been fed the mixed food eyed about fifty per cent better than those that had been overfed with the meat diet.

THE CHAIRMAN: What we are driving at is as to the relative value of raw meat and cooked meat for feeding adult trout to get egg results. We all acknowledge that you must not over-feed the trout.

MR. SURBER: In that same experiment, as I recall it, we were feeding all mush.

THE CHAIRMAN: We are talking about the cooked meat.

MR. SURBER: We were not feeding cooked meat at that time. It was raw meat mixed with the mush after the mush began to cool.

THE CHAIRMAN: It is evident that we have not got any control ex-

periments to ascertain the value of the cooked food as compared with the raw food in egg production. It is something we ought to work out.

MR. LEACH: I think in another year we shall be able to work that out, possibly at Nashua, N. H. The eggs we have received from some of the Colorado people who have been feeding their fish on cooked foods have not held up as well as those produced in hatcheries where they have been feeding on raw meat.

THE CHAIRMAN: Mr. Hayford spoke about shrimp bran. You buy the shrimp and grind them yourself, do you not?

MR. HAYFORD: Yes. I would like to say just one thing in regard to this matter of egg production and the feeding of cooked food. Where you take anywhere from a million and a half to three million eggs a year one of the big things you have to watch out for is to maintain the vigor of your fish. The percentage of loss on our brown trout from the green to the eyed stage varies considerably from year to year. We got into trouble with one lot of fish by putting them into the big ponds too quickly. We had a hot spell which jumped the temperature upwards seven or eight degrees all at once, and then it gradually went up twelve degrees, but the change was not enough to kill the fish or stop them from eating. It did however, cause an outbreak of furunculosis. The eggs from these brown trout showed the effects of the mistreatment of the brood fish, and the effects were apparent again in the second generation. Where the fish were not affected by the disease the loss in eggs kept dropping each year, until this year it was less than one per cent from the green to the eyed stage. You must take these factors into consideration, even back three or four years. As to our selected breeders in the brook trout, we found many interesting things. In one case this year we had a fairly heavy loss from the eyed stage to the time the fish hatched, and then from the time the young trout hatched and started off, the condition reversed and the percentage of loss was not as great up to six or seven inches as it was in the other cases. We put them in ponds which are fed from the same spring, under exactly the same conditions as to volume and temperature, and with the same kind of food.

THE CHAIRMAN: Does your paper on Selective Breeding pertain to food?

MR. HAYFORD: No, I covered all that last year.

MR. FOSTER: Dr. James Thompson has conducted a number of experiments with vitamin E on white rats—the vitamin which is directly responsible for the development or non-development, he claims, of the reproductive organs, and he suggests that vitamin E might apply to fish as well as to the white rats. This vitamin E is found largely in carrots and alfalfa. If this experiment on white rats should result in conclusions which may apply to fish, it may solve the problem in

regard to the quantity of eggs produced. I intend to make further inquiries in this matter by correspondence.

THE CHAIRMAN: Are there any more comments on this food question as relating to trout? Has Dr. Moore any suggestions to make?

DR. EMMELINE MOORE: I have not any suggestions to make, but I have a corroboration to offer. In a little experiment I was trying I ran about a dozen fry through chlorinated water, and then I used sterile meat to feed them. They took the meat well, but at that time we were having some trouble in one of our hatcheries with tail rot, and I tried to get those sterile fed fingerlings to take the disease. I was unable to do it. However, I think the experiment was hardly a conclusive one, because I had only carried them three weeks beyond the first stage. I was impressed with the fact, however, that I could not innoculate them with the disease—at least, not in three weeks.

THE CHAIRMAN: How did you sterilize your meat?

DR. EMMELINE MOORE: It was meat sterilized in the laboratory of the Veterinary College. They were using a large quantity of meat for making broth. They used the broth and I used the sterile meat.

THE CHAIRMAN: That was cooked meat, then?

DR. EMMELINE MOORE: Cooked meat.

MR. FOSTER: There is a firm in Kansas City making electrical instruments of some kind for sterilizing water electrically. They tried to get my interest in it at one time, but I did not see where the money was coming from—the price was $1,200 to $1,500. They claimed that they could run water through this instrument and render it devoid of all bacteria.

THE CHAIRMAN: Enough to supply a hatchery?

MR. FOSTER: Yes.

THE CHAIRMAN: That is interesting.

MR. LEACH: It may be of interest to point out that a firm in Brunswick, Georgia, are canning shrimp heads. They are canned about the same as salmon—put in a pressure cooker and sealed. At present they are doing this in order that we may try the canned shrimp at our Warm Springs, Georgia, station. The cans are opened, a little whole wheat flour mixed in with it; passed through the grinder and then fed to the small bass. They seem to take it very well, and so far they have made very rapid growth. It looks as if it is going to be an excellent food for small bass.

THE CHAIRMAN: Is it expensive?

MR. LEACH: No, it sells at about four cents a pound. The company is now experimenting with a can that will hold about four or five pounds.

THE CHAIRMAN: To go back to this experiment we made in our hatchery I want to say that the rearing was all done in troughs in the hatchery. We used all our inside troughs for rearing fingerlings up to four inches this year. We observed that the trout inside the hatchery, after

they have grown to say two and a half inches, do not thrive quite as well as trout in a battery of similar troughs outdoors. These troughs outdoors are furnished with hinged covers with cracks between. The covers are made of battens about three inches wide, with openings between of about half an inch so that there is always some sunlight going in, but not very much. Trout in the outdoor troughs did better than the the trout inside after attaining a size of two and a half to three inches. We also find that trout in the gravel runs do better after that age than the trout in the outdoor battery. We have made a lot of rearing pools following the topography of the valley, running from four to eight feet in width and about fifteen to thirty feet long: and from rippling water at the head where the water enters it runs to a depth at the outlet of from eighteen inches to two feet. These runs are all pretty thoroughly shaded. Some of the fish seem to be doing best in runs which are so shaded that the sun hardly penetrates to them.

MR. LAIRD: After the brook trout are four inches long do they feed at night?

THE CHAIRMAN: Oh, yes.

MR. LEACH: I am glad Mr. Titcomb brought up that point about his trout. Our experience has been the same: the trout we hold in the hatchery do not give the satisfaction that those do which are held outside in the troughs. In five different states we have tried out the experiment of holding our brook trout in troughs sixteen feet long and eight inches deep. The bottom is made of two pieces of plank twelve inches wide, so that if you use inch and a half lumber it makes a total inside width of twenty-one inches. These troughs were used in series of two, four and eight, and we gave each trough about twenty gallons of water a minute. The trough has a cover of wire screen, and eight feet in the center of it is covered with canvas or tar paper, so that it has four feet at each end open to the sunlight. The fish were put in these troughs about the first part of May and held until the latter part of June, then they were transferred to ponds that were shaded, or to natural runs in the stream. If we find a stream cut-off from four to six feet wide, we place a dam and screen at the head of the stream and also one at the foot. At one particular nursery in Michigan the stream is 500 feet long. It had open spaces where the sunlight filters into the stream. It had places where the trees grew so thick that it is entirely shaded. It had ripples and it had deep pools. For the most part the stream has a gravel bottom. In the latter part of June the fish are transferred either to a pond or the nursery streams, and there held until about the middle of September or the first of October; then they are distributed.

THE CHAIRMAN: Do I understand that you clean out these troughs entirely when you transfer to the ponds?

MR. LEACH: Yes, all fish are transferred from troughs to nursery ponds. About once a month we go over the bottom of the nursery

pond or stream, giving it an extra supply of water and stirring up the gravel bed. We find we get far better results under such conditions than where the fish are held in the ordinary hatchery ponds.

THE CHAIRMAN: In our hatchery we have not as much water to brag about as Mr. Hayford has, and we have to utilize it all. We keep the fish in the hatchery up to four inches because we have not room for them outside. We thin out every week as they grow and congest the troughs. We also thin out a battery of outdoor troughs in the same manner until we get down to about seven or eight hundred trout, to each trough, in August. We also have some wider troughs outdoors. The ordinary troughs are fourteen inches wide; these wider ones are about twenty-four inches. While we have not made any control experiments, we are inclined to think that we can carry double the number of the larger fingerlings in the twenty-four inch trough that we would carry in two fourteen inch troughs, and get better results. Now the difference between that battery of outdoor troughs and the gravel pools is not anything so remarkable so far as growth is concerned. We have not actually weighed to see what the difference is, but the fish are in better condition and there is less tendency to fungus. We have not had occasion to salt the gravel pools at all, but we have had to salt the fish in the troughs.

MR. HART: I was very much struck by what Mr. Hayford said about planting fish large enough for the sportsmen to catch. I believe we are going to find that the sentiment of the sportsmen will require us to give them fish large enough to catch. The fish culturists might anticipate that and govern themselves accordingly. The other day a man came into the office and showed me a paper in which it was stated that North Carolina had established I do not know how many hatcheries and had put out I do not know how many billion fry. He said, "The streams of North Carolina are teeming with fish, and Virginia is doing nothing." I could not say much to him, and I am impressed by the fact that every state needs a fish culturist.

THE CHAIRMAN: More than one.

MR. HART: Just as many as they can have. I do wish that every game commissioner who has anything to do with fish would stay here and here you gentlemen talk.

THE CHAIRMAN: I wish you would talk to them.

MR. HART: They do not know how much valuable information they are missing. Of course they do not know the scientific end of it; they are not expected to, but a great many points are brought up by you scientific gentlemen which would be of great value in their work. From what I can hear I do not believe the fish culturists are getting along very much faster than our game raisers. You will remember that Harry Rogers makes a point which bears on this: He says that in New York they have turned loose several hundred thousand pheasants, yet

when you go out hunting you find you cannot kill any more than two or three pheasants a season. I do believe that Mr. Hayford is working on the right plan. The sportsmen do not want fry placed in the streams and then get no fishing; they want something put in there that they can catch. They do not want birds turned loose and nearly all destroyed before spring comes; they want us to plant in the spring so that they can get the advantage, and they are right.

MR. LEACH: I do not want to criticize the New Jersey plan of raising fish. Mr. Hayford is working under orders and is producing what New Jersey wants. But I feel like one fellow down that way who said to me some time ago that when he wanted liver he wanted it with onions and not with fish. Mr. Hart says the sportsmen catch fish. Some people tell me that down there after the fish are planted—the large ones—they can go along the stream with a little liver and the fish will eat it out of their hands; in fact you can hold the liver in one hand and catch the fish with the other. So the sportsmen do not catch the fish. I believe the Bureau of Fisheries has got to get away from the idea of planting small fry. We are raising our fish to a length of about four inches, or until September or October, before distributing them. I believe that if we could hold these fish over until the close of the next fishing season and then put them in the streams, we would get far better results. I certainly do not believe in stocking a stream with ten or twelve inch fish, or fish above the legal limit. When you do that the people go right out and catch them almost before they have been in the water twenty-four hours. In New Jersey Mr. Hayford is furnishing a lot of people with a fish dinner on Sunday; they rush out on Saturday and catch all the fish there are in the streams. While he is having success in his work, I do not believe in the Bureau planting such large fish.

THE CHAIRMAN: When I first became a member of this Society the attendance at the meetings was never more than six, and three or four members would monopolize two solid days in a discussion of the question of fry versus fingerlings. Finally it was voted at one of the meetings that we would never discuss the question of fry versus fingerlings again, and I do not think it has been discussed since. Now we have come to the point of discussing the question of fingerlings versus adult trout. As Mr. Hart says, the sportsmen are demanding adult trout. The problem of food in the streams for the fish has to be considered. It has been my experience that some of the clubs which plant adult trout—Mr. Laird is on one of them—get so many adult trout into the waters that the food supply is completely exhausted, and when that happens it takes a long time to restore the stream to such a condition in the matter of food that it would be possible to return to the planting of fingerlings, because they would not find food there to nourish them. On the other hand, for the past four years we have been planting all

the fingerlings of from two and a half to five inches that the streams have capacity for. We have had good results with some of them; with others the results were very unsatisfactory. In those cases where the results were unsatisfactory, we believe the conditions were not favorable for raising the fingerlings under natural conditions to adult fish in satisfactory numbers. This year we leased over 140 miles of the largest streams in the state. We leased the fishing rights from the farmers so as to give the ordinary fellow who could not get away from the state some fishing without his being driven off. The matter of how we did it is foreign to the discussion. We decided that these streams were going to be fished so hard that if we stocked them with fingerlings they would be caught out day after day. No matter how careful the angler—and I am sorry to say that Connecticut is very much addicted to bait fishing—these poor fellows would never have a chance to go through until they were good sized fish. We therefore stocked that 140 miles with trout ranging from a little over six inches to nine or ten inches. This being the first season we were unable to do that stocking until about a month before the season opened, and some of them were put in during the fishing season. We were empowered to make regulations, so we deferred the open season for a couple of weeks in those waters to give the trout a little more chance. There was so much excitement in anticipation of the opening day that I started out for one of these large streams with a moving picture machine, prepared to get some publicity material. But it turned out to be so cold that the trout would not bite; you could put a worm right up to their noses and they would not take it, and very few were caught. They had been raised in a temperature of fifty to sixty degrees, and that day lines would freeze stiff when wet. But great numbers of the trout were afterwards caught; I presume that out of some 60,000 adult trout that were put in, 40,000 were caught. The anglers who had been accustomed to fishing with a fly in the wilds of Maine or Quebec did not enjoy that fishing; some of them said it was too tame. I judge from my observations that not more than ten per cent of the trout anglers know how to fish for trout, but a majority of the people who fished these streams did get a kick out of it, even if they did get liver fed fish. After they had been in that natural water for two or three weeks you would not know the difference between them and the wild trout, as to taste. You could tell the hatchery trout every time as to markings, and it was not as gamey as the wild trout.

In one instance we had a truck break down near a pool in the stream crossed by a bridge, and we put the truck load of fish into the pool. The pool was about the width of this room and four or five times as long. You could go to that bridge at any time during the open season, throw in a cracker, some hamburg steak, or almost anything, and have a school of trout rise to the surface just as they do in the hatchery

ponds. They stuck to that pool very closely, and as we saw there was going to be slaughter if we did not take action we closed the pool to fishing during the entire season. It was quite a publicity stunt, because a lot of people did not think that we had planted adult trout. When planted these trout ranged from six to eight inches in length, some of them nine inches. Some of them spread to waters below, and one of my friends, fishing below the pool where he had to let his line down in the brush quite a distance, caught eighteen trout that weighed ten pounds, and did it in half an hour. They had been in the stream about eight or nine weeks and had attained a remarkable growth. They weighed over half a pound apiece, and were very satisfactory to the fisherman

MR. HUNTER: How old were these fish then?

THE CHAIRMAN: They were yearlings—that is, they were about a year and a half old, having been hatched in January of the preceding season. This place was within three miles of Willimantic, a small city. All the anglers who fished the stream above went to this bridge on their way to the fishing holes, and on their return. A good many of them bought hamburger steak and fed it to these trout off the bridge.

Now, as to the point brought out about your liver fed fish, and the desirability of having onions with your liver, there is another side to that question that has got to be considered from the anglers' viewpoint. Reference has been made by Mr. Hart to the pheasants. We have distributed 6,400 pheasants this year, fourteen weeks old—strong, flying birds. Most of the cock pheasants of that lot will be shot this fall. Our sportsmen will kill something like 10,000 pheasants; in other words we put these pheasants out with the idea that they are going to give the sportsmen fun this fall, but we do not allow them to kill the hens, so we have some breeding stock. We are now taking the same view with reference to the introduction of trout into these leased waters. We are putting them there for the fishermen to catch, and we do not care whether they have them for Sunday dinner or not. We are trying to give the angler a run for his money, and the plan has been very popular. We had a special appropriation of $50,000, besides the license money to do this work with, and we were intending to carry it out hereafter from the revenue from the angler's license, which has been doubled, largely on the promise of what we were hoping to do. Because of its popularity I rather think we shall need another appropriation this winter to enable us to extend this work. We are not in a position to produce large numbers of adult trout, and we are not promising the sportsmen adult trout except for these leased streams. Some of these waters are very warm, as it developed this summer in time of drought, and the trout that survive go to the small streams. Quite a lot of them are left over to breed this fall. I do not think we can say that it is necessary to depend on fingerlings if we can afford to plant

adults. I think the problem is very largely a problem of food; we are over stocking when we plant these adults to any very large extent.

I may add that we furnished patrol men for each of these streams in order to protect the land owners against vandalism, the crossing of cultivated lands, and so forth. The patrol men checked up each fisherman encountered and recorded the number of fish he caught. On an eight mile stream he checked up 994 fishermen, and they had 2,019 trout. He checked some just as they were starting in the morning, and he checked some at night. Twenty trout was the limit. On another larger stream he checked up 715 fishermen who had 753 trout. On this stream where we had the protected pool he checked up 1,002 fishermen who had 2,292 trout.

MR. FOSTER: Is that daily?

THE CHAIRMAN: That is the season's catch, from the fifteenth of April to the first of July. On another river he checked 1,024 fishermen who had 2,107 trout. On another stream which is within fifteen minutes ride of Hartford he checked 2,918 fishermen who had 4,840 trout. In other words these patrol men on the various streams checked up 6,848 anglers who had 13,175 trout. These figures, although they do not, of course, indicate what the fishermen actually caught, are interesting, because a large majority of the trout they had were hatchery raised trout; you could tell the wild ones. Each angler may have caught his limit after being checked by the patrolman. The figures do not approximate the total catch.

MR. HUNTER: How much does it cost you to lease that 140 mile stream?

THE CHAIRMAN: We paid one dollar to each landowner for four years—a nominal sum.

Connecticut is a very thickly settled state, and being an industrial state the population is in the cities. Thirty-seven per cent of our land is uncultivated, and that is why we have such good grouse cover, as well as many small trout streams and a few larger ones. The trespass law is a very drastic one. You are not obliged to post your land; if a landowner sees you walking on his premises he can arrest you. If you pick berries on the highway in front of his house he can arrest you, because the highway is merely a passageway through his land, and he can get a fine and costs too. The landowner is trying to keep these people off, because, as in other states, he has been overrun by vandals who come out in cars, camp on his property, spread their Sunday papers and picnic boxes round about, and so on. Besides, he has had fires started on his property, and of course he has the angler and the hunter invading his premises at different seasons of the year. He has become discouraged about keeping these people off. He cannot arrest them unless he is bigger than they are, and it is hard to identify

them if they get away from him. Sometimes, of course, they take the registration numbers of the cars and get them that way.

Perhaps you know what it is to make an agreement with a New England farmer, and I presume the farmers in other parts of the country are the same; they have been fooled a good many times. We got an agent who was very competent for that particular kind of work. I do not know that I could get another man in the United States like him. He dresses like a blacksmith, a clean, shrewd fellow, with a pock-marked face, wearing a black shirt and old trousers. He has been thrown out of some houses and refused admittance to others, but he is shrewd enough to excite the curiosity of the farmers; they want to find out what he is after. He is patient until he excites their curiosity and then he tells his story. He promises them that if they will turn over the fishing rights on their land the state will stock the waters with adult fish; that he will have the privilege of fishing there without a license, as he does now; that a patrol man will be provided who will see that the fishermen keep within ten feet of the water's edge when they pass down the stream; that they will not cross his cultivated land; that they will build no fires; that if on his wild land he wants to designate the trail we will have a sign at each end of the trail to indicate the entrance and exit. Furthermore, we build stiles at every fence line, so that instead of cutting wires and letting the cattle out the anglers simply walk up over the fence and down the other side. That has pleased the lessors as much as anything. Under our regulative power we have the right to take a man's license from him if he is found violating any of these regulations. We put up posters stating that these are state-leased streams and pointing out that the regulations must be observed. On the whole we have had very little trouble and the farmers were very much pleased. We have paid out something like two hundred and fifty checks for one dollar to reimburse the farmers for these fishing rights, and we must have built one hundred of the stiles.

Now, Mr. Hayford has had a good deal of experience with the stocking of adult trout, and perhaps he would like to say something on that.

MR. HAYFORD: First let me get Mr. Leach straight on the liver and onions. In December of each year there is a meeting of our sportsmen from all parts of the state, from five to seven hundred of them, and as a rule three or four commissioners are there. I always attend these meetings, and I also come in contact with the fishermen by spending every weekend out among them. We are in a position, therefore, to know what the sportsmen want. You do find some who kick about liver fed fish, but they want fish of huge size put out. Of our last three governors there were two who were not interested in the man with money and an automobile who could go to the Adirondacks; they insisted on our running the Fish and Game Department to produce

for the poor workingman who has not the money to go a long distance for his fishing, but who does pay eighty to ninety per cent of the revenue. So there is that to be considered in a thickly populated state.

But there is another thing: probably eighty per cent of our fishermen do not get more than one or two days in the fall to go hunting and perhaps two days in the spring to go fishing, and that is why the majority of the sportsmen insist that there shall be something in those streams for the fellows who have so little time as that for sport.

As to the methods of putting out the big fish, we use the trucks and tanks and scatter the fish thinly all along the streams. The fish are not fed for seventy-two hours before they go out. We will take 500 of these large fish and scatter them along three or four miles of stream. Where we cannot get to a stream except once in a while we have to put in more than we like to at some particular spot. Many a time after these fish have been planted there was nothing you could use that would make these fish strike—dry flies, shells, white flies, spoons—nothing was effective, even in the hands of the most expert fishermen. Now, why? For the simple reason that most of our streams are heavily stocked during the early summer with caddis fly larvae, stone fly, and so on, and are teeming with small minnows, such as the small sucker and the shiner. One fellow who had not had much luck suggested that I take a try at it, so I covered the fly with sheep's plucks, liver and lungs, and took out three one after the other. He happened to be a newspaper man, so you fellows can figure out the rest.

It is an expensive proposition to produce these fish. But there is this to be remembered: You can charge a man ten cents and give him nothing for it, and he will raise a howl; charge him $10 and give him something for it and he will be satisfied. They are willing to pay the bill. Our condition is different from that which obtains almost anywhere else. Every one of our streams is within two or three hours of one-seventh of the population of the entire state, and the sportsmen demanded that we discontinue putting out the little stuff.

Just before the trout season opens, our Commission send information to the leading newspapers as to where these fish have been planted in a thousand miles of stream, with notes as to species, the number and the size. If those fish are not there when the sportsmen go after them, somebody has got to answer for it.

MR. LAIRD: Speaking about the depletion of food supplies by the putting out of large fish, we overcome that by the purchase of 75,000 Caledonia shrimp every spring, and they are scattered all over the property so that they have a chance to propagate. They frequent the moss and weeds, hiding by day and feeding by night, and they multiply and furnish food for the trout. After these artificially fed fish are out for two weeks you would never know they have had a bit of liver; they are bright and hard and as good as any wild fish you can get

anywhere. And they will not eat out of your hand, either; you have got to fish for them.

THE CHAIRMAN: I am glad you brought up that question, because I want to correct the impression that has gone all over the country that shrimp can be put out anywhere in the streams and the same results produced which you got. You can only do this in exceptional cases. Down on Cape Cod, in the vicinity of Wareham there are a great many reservoirs which are drawn on for flooding cranberry bogs at this time of year when there is a probability of frost. They are all fed by springs, the same underground stratum that supplies all the commercial hatcheries of that region. One of our Massachusetts Yankees who was formerly a fish culturist and who still runs two trout hatcheries has become quite expert at raising cranberries, but he cannot get away from the trout game. These reservoirs are stocked heavily with shrimp, which thrive there wonderfully, and he has found a way of disposing of the product of his commercial hatcheries by raising them to fish nine or ten inches long and stocking these chanberry reservoirs, some of which he owns and some of which he has leased for the fishing privilege; he invites people from Boston, Providence, and places which are within two or three hours run of Wareham to drive down there and use these waters as a fishing club. The fish of these reservoirs, just as Mr. Laird says, do get a wonderful color in a very short time; they soon take on the markings and spots of the wild trout. I went down there and made personal observations and I want to correct any impression that some reader may get—some angler perhaps—about stocking trout streams in general with shrimp. I think Mr. Max Hart's bull will apply to that statement in ninety-nine cases out of one hundred, when it comes to general stocking with shrimp, because they will not thrive except under certain conditions. You have got to have cold spring water, and you must have certain qualities in the water, some of which, perhaps, we do not know enough about. You cannot do it with the general run of streams that Mr. Leach is stocking.

MR. LEACH: I wanted to place you on the defensive in regard to your program of stocking with the larger fish. Of course we know that in some places it is a matter of policy because your state organizations demand it, and you have to cater to them. Mr. Laird and Mr. Hayford are working in very congested districts where the streams are more or less short, and if they are going to have fish for the public they must give them fish that the pubilc can catch, because many of the fishermen are not like those you find going into the north woods of Canada, or the Rocky Mountains, using dry flies. It is a matter of policy for states, I am wondering how far we should cater to the demands of the sportsmen. Of course in the concentrated districts, the sportsmen are going to pay the bill, probably it is no more than right to give them what they pay for. On the other hand the Bureau does the best it can for the fishing public, so why make the general public

pay for the benefit to be derived by the few? For that reason we have adopted the co-operative system of raising fish, which throws the burden of raising the fish or of feeding them—the expense of it, at least—on the sportsmen who are getting the benefit. I think that, so far as we are concerned, is the proper thing to do. We cannot compete with the states in raising large fish to stock streams. If we had to raise our fish to the age of eighteen months to two years and transport them for instance from White Sulphur, W. Va. to Pennsylvania, the cost of transportation would be prohibitive. Many of the eastern state hatcheries in the congested districts can distribute all their fish by truck and at very little expense. But the expense is a considerable item for the Bureau of Fisheries—not the expense of feeding the fish, because that does not cost them any more than it would cost you, but it is the problem of transportation.

THE CHAIRMAN: There is no doubt, Mr. Leach, that the states can afford to do things in that regard that you cannot afford to do. The question as to whether the Bureau should be doing any stocking of trout would perhaps be raised by some—whether that kind of work ought not to be done entirely by the states. But I want to say in connection with your remarks, from my viewpoint as a state official, that if I was working in Montana or some state with virgin waters, I would not think of planting those large adult trout. But our physical conditions are so changed—if you heard my paper on Deforestation to-day you would get a pretty good idea of it—that it seems to be almost a waste of money to plant small fish.

MR. FOSTER: It is all a sectional problem. In some of the streams in our state parks in Missouri we plant fish of sufficient size to catch out, but in other parts of the state we would not think of doing it.

MR. HUNTER: In stocking the streams in Connecticut have you ever tried closing them until the small fish matured?

THE CHAIRMAN: We have not done that in Connecticut. In Vermont we have in some cases closed a stream for three to five years. The result was that a few poachers would go in and get the cream of the fishing during the closed period, unless we kept a man on the stream all the time. At the end of the three to five year close season, during which the stream was posted, the anglers were lined up on that stream about midnight, or soon after, and very shortly after the season opened that stream would be depleted and reduced to the condition that obtained before it was closed. I believe it would be better to close the tributary streams permanently instead of taking advantage of the law which provides for a close season for a period of three to five years. In connection with this lease proposition that we have undertaken in Connecticut, I may add that there are certain small tributary feeders controlled by the same land owners, on which they gave us certain fishing rights, and those streams are permanently closed as long as our present system prevails. They will serve the purpose of breeding brooks.

A NEW GILL DISEASE OF TROUT

By H. S. Davis.

U. S. Bureau of Fisheries.

During the past summer considerable trouble was experienced at the Holden, Vermont, experimental hatchery with an infection of the gills which has not previously been recognized. The disease appeared during July and August in several lots of fish and is evidently capable of causing serious injury to fingerling trout. Fortunately it appears to be easily controlled and there is no reason to believe that it will develop into a serious menace to trout culture.

The disease first appeared early in July in a lot of brook trout fingerlings which were then about two inches long. These fish were in excellent condition at the time and were making a very rapid growth. They were being held in a dirt pond supplied with a good flow of spring water at an average temperature of about 55 degrees. There were relatively few fish in the pond so that overcrowding could not have been a factor in the development of the disease.

Early in August there was an outbreak of the same disease in a lot of steelhead fingerlings which were also confined in a dirt pond supplied with spring water and still later in the season it appeared among some brook trout fingerlings in a pond immediately above that occupied by the steelheads. There were also some losses from the disease among fingerlings of rainbow trout, black-spotted trout and land-locked salmon.

The general course of the disease is well shown among the brook fingerlings in which it first appeared since in this case no corrective measures were adopted to halt the course of the infection. There were approximately 5,000 fingerlings in this pond and the mortality was very slight until about July 10 when the losses rose to about 10 to 15 fish a day. The fish continued to die at this rate until July 22 when the mortality rapidly rose to about 40 fish a day. This sudden increase in the mortality was probably indirectly due to a period of very warm weather during which the temperature of the pond rose to 59 degrees. With the advent of cooler weather several days later the losses rapidly decreased and by July 29 had almost entirely ceased.

It will be noted that in this case the epidemic developed

gradually, more and more fish becoming infected, and reached its climax during a period of exceptionally warm weather after which the fish rapidly recovered. Owing to the writer's absence from the station during the time the epidemic reached its height the extent of the infection was not determined but investigations of later outbreaks of the disease indicate that in all probability the great majority, if not all, of the fish in the pond were infected to some extent.

In this case the mortality was quite low in comparison with that of most epidemics among trout at this age but it should be borne in mind that the fish were being held under exceptionally favorable conditions and that if they had been overcrowded or subjected to other unfavorable influences the mortality would probably have been much higher.

In the case of the steelheads in which the disease appeared somewhat later the mortality was much higher but, unfortunately, the fish were also heavily infected with Octomitus and there was no means of determining what percentage of the mortality should be ascribed to these organisms.

A careful study of the disease has shown that it is due to an infection with bacteria which form a luxuriant growth over the surface of the gills. The bacteria occur in the form of long, thread-like filaments which usually lie side by side to form a more or less continuous layer over the surface of the epithelium. These filaments are colorless, transparent and so difficult to distinguish that it requires very careful focussing with a high power lens to make them out as they lie on the surface of the gills. The bacteria are most abundant on the outer third of the gill filaments where, evidently as a result of the irritation set up by their presence, there is a rapid proliferation of the epithelial cells. This results in the free ends of the filaments becoming enlarged so that they are often more or less distinctly club-shaped. One of the most striking features of the disease is the fact that as a result of the rapid increase in the thickness of the epithelium the gill filaments often become fused, especially near the tips, and in extreme cases all the filaments of each gill may become united into a continuous mass. In some cases the thickened epithelium can be distinguished with the naked eye, the ends of the filaments appearing white and much larger than normal.

Sometimes the gills may become necrotic, a condition which is quickly followed by the development of fungus and the fish succumbs within a few hours.

There is also a greatly increased secretion of mucus over the gills in which particles of sand and debris become entangled. This, combined with the enlargement of the filaments, must seriously impede the circulation of water over the gills and consequently interfere with respiration. The free interchange of gasses in the gills must also be hindered by the thickening of the epithelium which results in several layers of cells separating the blood vessels from the water instead of only one or two layers as is normally the case.

The appearance of the gills is the only criterion by means of which the disease can be recognized. In other respects the fish exhibit no characteristic symptoms, and in fact appear practically normal until a very short time before death.

It appears to be characteristic of the disease that the largest and most vigorous fish are as liable to succumb to its effects as are the smaller and less robust individuals. In fact, in some cases it almost seemed as though the mortality was confined to the largest and finest fish in the pond.

Inasmuch as the disease is caused by bacteria which are found only on the surface of the gills it is evident that it should be more easily controlled than one which is due to internal parasites. This assumption is borne out by practical experience since it has been found that the infection yields to the treatment which we have used with success with other bacterial diseases. This consists in dipping the fish for one minute in a 1 to 2,000 solution of copper sulphate after which they should be quickly removed to running water. If carefully done only a few of the weakest fish will be injured by the treatment. One treatment was found to kill most of the bacteria and if followed by a second treatment the following day they are entirely destroyed. In most cases the fish quickly recover from the infection and the gills resume their normal appearance.

For best results the fish should be treated on the first appearance of the disease since the infection can then be checked before the gills are permanently injured.

As all trout culturists know so-called "gill diseases" are quite prevalent at many hatcheries and often cause considerable mortality. At present, however, we do not know whether or not all are due to the same cause but from the

information at hand it appears probable that there are several forms of "gill disease" due to quite different factors. Up to the present the bacterial infection just described has been found only at the Holden hatchery but it is logical to assume that the organism occurs at other hatcheries as well. As previously pointed out this can only be determined by a microscopical examination of the gills of infected fish since there are no symptoms, other than the appearance of the gills, by means of which the disease can be recognized with certainty.

Discussion.

DR. EMMELINE MOORE: Did Dr. Davis experiment with anything except copper sulphate?

MR. LEACH: He has tried practically everything that was on the market.

DR. EMMELINE MOORE: Potassium permanganate?

MR. LEACH: Not in this particular case.

THE PRESIDENT: He used copper suplphate for tail rot or the fin disease, and it was successful if taken in time.

MR. LAIRD: There is a fish hatchery eighteen or twenty miles east of us on Long Island, owned privately. The owner had some trouble this summer with what he called a worm in the tail of the fish. Did you ever hear of that?

DR. EMMELINE MOORE: I wonder if he meant gyrodactylus?

MR. LAIRD: Perhaps that is what it was. He said he cured it with vinegar.

DR. EMMELINE MOORE: That is doubtless what it was.

MR. DOZE: Does the tail rot affect the tails more than the fins?

MR. FOSTER: The gill in this case turns brownish and sloughs off. It literally rots off the gill.

MR. TITCOMB: We had fin trouble last year with some of our trout. This year we had tail rot in eight troughs, with very little infection of the fins. In neither case have I noticed any trouble with the gills.

MR. FOSTER: I had a case of fin rot, and when the fish got about three inches long it disappeared. Of course I treated them for it. Then in a month or so this gill rot showed up. Whether it is the same bacteria or not I do not know, but from general experience I should say it is much the same. If the fish can be removed from their quarters, thinned out and turned into a larger volume of water, it helps materially, but if you have all your ponds full and you cannot change them, then it is a slow course of losing your fish.

MR. LEACH: I believe copper oleate has great possibilities in fish culture if it is rightly used. For certain diseases, if you could drop the copper oleate into the water at a certain rate it might effect a cure. A few years ago we had a fungus growth on our Cape Vincent, N. Y. whitefish eggs, a fine filament. It would cause the eggs to float out of the jars. The dropping of copper oleate into the water at a certain rate would cut the filament off the eggs and they would settle back in place. It was only necessary to do that about twice in a season to clean up all the eggs.

MR. TITCOMB: It has just occurred to me to bring up one point which was new to me. I have observed in the reports of some of the marking of salmon on the Pacific coast—and I think it has been used in other places—that they sometimes cut off the adipose fin and expect that it will remain that way and not rejuvenate. Last fall I marked a thousand six inch fingerlings by cutting off the adipose fin; we were trying to determine the results from stocking in a certain small trout stream, and we put those fish into that stream. This spring, early in the season, they reported no results—this stream was under private control; but later in the season they reported that they were catching these fish in considerable quantity, and that the adipose fin had completely rejuvenated. When Dr. Davis passed through the other day I spoke to him about it and he said he had made the same discovery this summer: he had cut the adipose fin off some trout and it was rejuvenated in three months. I do not recall the size he used.

MR. LEACH: I suppose they were the small fish, two or three inches in length.

MR. TITCOMB: In the case of the small fish the rejuvenation would no doubt be more rapid than in the larger ones.

MR. LEACH: We cut the adipose fin off salmon in Alaska, and we picked some of them up three or four years later with the fin still off. It might be that some of them grew out and others did not.

MR. HUNTER: I know that it is only a comparatively small number of the salmon that we get back. I never suspected that the fin might grow out again.

MR. TITCOMB: It certainly does with brook trout.

MR. LEACH: That is one reason why we discontinued that method of marking and adopted instead the aluminum plate.

MR. LAIRD: I would like to ask Dr. Moore if she has heard of any further study being made in regard to the source of Onchobothrium? Has anything been done about that gill worm in New York state?

DR. EMMELINE MOORE: I do not know anything about it, Mr. Laird.

MR. LAIRD: At our place on Long Island we have a little of it all the time. It is not an epidemic at all, but nearly every adult fish I pick up dead has that grey worm in the gills, and there is no apparent way of knowing it until the fish is practically done for.

CO-OPERATIVE FISH CULTURE

By Glen C. Leach.

Chief of the Division of Fish Culture, United States Bureau of Fisheries

To those of you who were not present a year ago I wish to say that the plan of co-operative fish hatcheries was instituted by the Bureau of Fisheries to meet the necessity of stocking streams with larger fish. We have been forced into this by many of the States, who have realized the importance of that method of stocking. Sportsmen's organizations throughout the country and such influential people as are interested in fish and fishing have been putting pressure on the Bureau and saying: "The States are doing it, why can not the Bureau of Fisheries?" Well, we feel that to a reasonable extent if a State can do a thing the Bureau can do it too, though the Bureau has been handicapped. Our hatcheries were laid out a number of years ago and were not planned for with the view of producing large fingerling fish, the idea seeming to prevail that a hatchery should have a large output of fish regardless of size. But stream conditions have changed, deforestation and the cultivation of land have contributed to that change. The streams produce less food than formerly for the maintenance of small fish, making it necessary, especially in the more thickly settled parts of the eastern sections of the country, to plant larger fish. Many of the States are going even beyond the large fingerling stage and are planting six or eight-inch fish and fish above the legal limit. There is no doubt that in some places the planting of such large fish is an absolute requirement on account of changed conditions in the streams. We have, therefore, been trying to follow that scheme in a general way, and we feel that the burden of producing larger fingerling fish should be placed on the sportsmen or on the people who reap the benefit of such stocking. Thus it was that the idea of the co-operative fish hatchery has been carried out and at the present time I suppose we have something like fifty or sixty of these projects, some in Colorado, some in Missouri, in Texas, Michigan, Pennsylvania, and at points in the New England States.

Our plan has been to furnish to an organized club of sportsmen a certain number of fish along in May after they

had been feeding for about six weeks, thus relieving the crowded condition of our hatcheries. At that period of development the fish can be transported about one thousand to the can, making it possible to deliver to such an organization about 20,000. The fish are placed in troughs sixteen feet long, approximately two feet wide, and eight inches deep. A trough of this sort is supposed to be supplied with anywhere from fifteen to twenty gallons of water per minute at a temperature suitable for trout.

The troughs are covered with wire screen and in the middle portion a space of eight feet is covered with canvas or tar paper, to provide the necessary shade. The trout are held in these troughs and fed regularly until the latter part of June, when they are transferred to a small stream or to small ponds and held there until October. In October the Bureau sends a man to the co-operative hatchery to get the fish out of the ponds, place them in cans, and give them to applicants. In many instances the applicants are members of the club but we are not interested in that. We only want to be sure that the fish are distributed in that immediate region. They are not used for distribution in other sections of the State, that is, we aim not at a wide but a local distribution. Fifty per cent of the fish are the property of the Bureau and we reserve the right to distribute them to any one making application for them in that immediate section. The remaining fifty per cent belong to the club and they may be placed in club waters or anywhere that the club may decide. The club bears the expense of caring for the fish after they have been delivered at the co-operative hatchery. The Bureau sends a man to these places once every month or two to inspect the plants and give instructions in regard to the proper care of the fish.

This scheme has worked out very well. A Williamsport, Pennsylvania, organization, to whom we sent 55,000 fish in May, informed me when I visited their place about a week ago that their losses up to that time had been less than one thousand fish. Of course they did not know what losses had occurred from cannibalism, from birds, or other causes. The members were simply speaking of losses that had been observed in the ponds and troughs. They have an attendant at the club the year around, so that the fish are well cared for. The club expects to hold its share of the fish over until next September—they have ample pond room—so that they will be cared for until after the close of the

fishing season when they will be placed in the streams. This will give them fish from six to eight inches long for stocking the streams in which the association is interested.

Were the Bureau to hold these fish until October and then send them, say, from its White Sulphur Springs, West Virginia, station they would constitute about two carloads, making a cost for transportation alone of twelve hundred dollars. So it would be practically impossible for the Bureau to hold the fish at its White Sulphur Springs station to attain the size referred to, even if the pond room and water facilities were available, for distribution in the fall.

In the State of Pennsylvania, which operates about five hatcheries, fish are held until from four to five inches long before they are distributed. All of the State fish are distributed within a short range of the hatcheries, so that the transportation problem is hardly worth considering. It is probably not necessary, therefore, for many of the States to undertake this co-operative nursery proposition.

An organization at Harrisburg, Pennsylvania, thought so well of the co-operative scheme that it bought sixteen acres of land, constructed three ponds, put in troughs, and will build a small hatchery this fall. This entire equipment will be turned over to the Bureau. The Bureau now has one of its statutory men at that point to take care of the fish on hand. During the coming October we will make a distribution to points on various railways within 75 miles of Harrisburg. In most instances people from the smaller towns will go to Harrisburg in their automobiles on the day specified for the general distribution, receiving their fish and make the distribution themselves. In this way the cost of distributing the fish will be very slight so far as the Bureau is concerned.

In former years we have sent annually from the White Sulphur Springs (W. Va.) station a carload of fish to Harrisburg during May, distributing them when from 1 inch to 1½ inches long. This year we sent the usual carload to Harrisburg but the fish were held there for distribution in October. I feel quite safe in saying that out of the 150,000 fish we started with last spring we shall distribute at least 100,000 and possibly more. The fish will average in the neighborhood of 200 to a can and were they to be sent from the White Sulphur Springs station it would require from three to four carloads to carry them. It can readily be seen, therefore, that by sending them to Harris-

burg in the spring of the year the Bureau makes a saving of almost $2,500.

We have been co-operating with several clubs in Michigan. In one particular instance a splendid trout stream averaging from 40 to 50 feet wide, with clear water of good volume and a nice gravel bed, had become filled with logs and debris through the cutting of pine timber over a long period of years. A club in that section cleaned up over three miles of the stream. A dam was constructed at its lower end near the point where it enters South Branch, a river flowing into Thunder Bay. All logs not solidly embedded in the stream were removed, all the brush was cut out, and the club members even went so far as to take out bark and other debris, throwing it on the banks. At the dam—about 1 foot in height—a rack was installed to prevent the fish from going upstream. The stream is to be stocked this fall with large fingerling fish and they will remain undisturbed until they reach spawning age, at which time we expect to take the eggs and utilize them at our hatcheries.

Branching off from this main stream is a cut-off about 500 feet long and 6 feet wide, exposed in some places to the sunlight, passing through more or less meadow land, and at other places covered with trees to the extent that it is densely shaded. In this stream we placed a rack at both ends to protect the fish and about the first of July 90,000 small brook trout were turned loose in the cut-off which, by the way, has a gravel bottom. The water supply was regulated by a dam with sluice boards so that we could maintain any water volume we desired. The fish were held here until about September 1st when we took out by actual count 70,000 brook trout ranging anywhere from 3½ to 4½ inches long and delivered them to applicants. The club received 35 per cent, which they used in stocking their own waters, and they gave the remainder to applicants to stock waters of the surrounding country. They invited people to come in with their automobiles and receive the fish—one can, two cans or a dozen cans, if they could carry that many—and distribute them in neighboring streams.

The Michigan laws provide that the stocking of streams by either the State or the Federal Government at once opens them to public fishing. This club did not want to take any chance on its streams being opened to public fish-

ing, so they bought the eggs and delivered them at the Bureau's Northville (Mich.) station, where they were incubated, the young fish resulting from them being delivered to the club early in May. They were held at the club's expense and fed by an experienced man from the Bureau's station during the summer months, the club paying his expenses while so detailed. The Bureau did not own the eggs or the fish, nor was it put to any expense in connection with the production of the fish with the exception of the man's salary. At the same time it was benefited by the transaction and if the man who was engaged on this detail for three months had been employed at one of the Bureau's hatcheries his services would doubtless have been utilized in mowing the lawn or other work of similar character, which could be done by almost any one. In other words, we feel that the man's services were employed to better advantage in producing 70,000 fingerling fish, which were easily worth at least $50 a thousand in that region, and the benefit to the Bureau came through the distribution within a radius of fifty miles of a large number of fingerling fish which could not otherwise have been produced, owing to lack of rearing space and an inadequate water supply at the Northville (Mich.) station. Even had the fish been available at the station the cost of distributing them would have amounted to a great deal more than the salary of the detailed man. There are many instances such as I have just described.

We are trying to establish co-operative bass hatcheries and the prospects are that several of those now in operation will do successful work this year. Last year a co-operative bass hatchery was established near Rutland, Vermont, an old abandoned mill pond of about 15 acres being used for the purpose. As the Rutland Fish and Game Association was very much interested in this project, we inspected the pond, secured a few adult fish in connection with our operations on Lake Champlain, and sent them to the club. From the 75 to 100 adult bass placed in the pond in advance of the spawning season there were taken out of it approximately 40,000 bass ranging anywhere from 3 to 5 inches in length and distributed by the organization in local waters. This number would have meant two large carloads of fish had we sent them in from a point further away.. As it was they were produced at practically no expense to

the Bureau except for the inspection trip and the cost of messenger service from Swanton to Rutland, Vermont.

A great many clubs throughout the country, especially in the South, are interested in the production of bass, and I think we shall be able to work out some scheme whereby bass production can be increased without any material increase in expense to the Bureau. We feel that by working with the clubs and having them set aside one or two of the many lakes which they frequently have we can produce bass locally and thus benefit all parties concerned. It is quite evident that the Bureau can not long continue its present practice of taking bass from the overflowed regions along the Mississippi River. It is common knowledge that when the main channel of the Mississippi overflows the fish get into pools which evaporate during the course of the summer and if the fish are not seined from these places they are lost, as in cases where the pools do not disappear through evaporation they are apt to freeze to the bottom during the succeeding winter. For a number of years the Bureau has been salvaging the fish from landlocked pools along the Mississippi River and distributing them. The people of the region are of the opinion that we ought to place all of these salvaged fish back in the river. They may be right about that. Fishing in the Mississippi River should certainly be maintained and there is no reason why the Government should not return the fish to the waters in which they originated. Under the circumstances it seems that we must work out some scheme in the various parts of the country, especially in the South where the demand for bass is very great, to supply this important fish.

We are now working on a project in Georgia where we hope to obtain a large acreage and establish one of the largest pond-cultural stations in the country, one where bass can be produced on a large scale under natural conditions. We have been making a very careful survey and when that pond station is established I think it will be a base from which we can work along the line of co-operative effort for the production of bass on a large scale.

A great many organizations have said that if we could not establish a hatchery in their locality they would like to know in what way we could help them out. I think where they have small ponds from 10 to 25 acres in area we can work from these as a base, give the co-operating organizations a start, and make them self sustaining from

that time on. Managing in this way I believe we are going to be able to increase very largely the production of fish, especially large fingerling trout and bass.

A great many sportsmen are much concerned over the distribution of bass. If we deliver them a thousand bass that you have to hold up in a glass of water to see they are doubtful about the results, and they are probably right. If we can furnish them 1,000 or 2,000 bass four or five inches long I think we shall get better results. At least the people who receive the fish will take more interest in them.

Another thing the co-operative fish hatchery does is to give the sportsmen a different view of fish-cultural work. If you wire a man to meet a messenger shipment of fish at a station and the only expense to which he is put is to knock off for a few hours to go and get the fish he will not take the same amount of interest in the matter that he would if he had to pay for the fish. When an organization is formed and its members contribute a certain amount of money toward the building of troughs and for fish food and the care of the fish every man in that organization will feel that he has an interest in the fish that are being produced. He tells his friends and they visit the co-operative nursery whenever they have the time and look the plant over. On Sundays especially these co-operative nurseries are crowded. They tell me that at some of the more important ones from 50 to 100 cars are frequently parked outside on Sunday, indicating the number of interested people who go to see the work for themselves. So the man who pays, the man who invests his money in such a project has an interest in seeing it brought to a successful issue. Nor does the interest of the individual member of a club cease after the fish have been received and planted. That man is going to take an interest in the fish in the stream. He is not going to see any one fish illegally without a protest or some action on his part. He will report such unlawful action and will see that it is taken up through the proper channels.

We find that on account of this co-operative work greater interest is being manifested in the protection of fish. It is the opinion of the Bureau of Fisheries that protection is probably even more essential than production, because if you do not protect the fish after they have been planted it will not make any difference what size fish you plant,

there will be no results. I feel that this is one thing to which the States should give greater consideration—the protection of fish and of game. Judging from what I have seen of the progress made in protection, especially in the Eastern States, I believe the time is not far distant when our streams will be as well protected as our streets, that the States will provide an efficient police force, and that they will give more consideration to the protection of game fish. In that way we shall have better fishing.

In some of the States, however, fishing conditions will be hopeless before long if the streams are not protected more or less by some well organized scheme. The fishing is being rapidly depleted and the prospects are that it will be only a short time until the streams are entirely barren of fish life. That applies especially to sections of the country where the foreign element is present in considerable numbers. It seems to matter little to the average foreigner what sized fish he catches so long as it is a fish. They are taking the small fish and of course that means a rapid depletion of the streams. I am glad to say that most of the States are giving consideration to this very important feature of the work. We think the work that the Bureau is doing in the establishment of co-operative hatcheries is causing clubs and individuals to take a greater interest in protection and that it is going to be the salvation of our fisheries in the future.

I wish to thank you for listening to this. I feel that it is such an important matter that we should give it the very closest attention. While you are working for protection in the States we have to work through individuals and the clubs to bring them in and to give them an interest in this work so that they themselves will be concerned in the matter of protection.

INCREASE IN THE SALT WATER SHRIMP CATCH FROM LOUISIANA WATERS

By E. A. Tulian.

Director, Fisheries Division, Department of Conservation of Louisiana.

The catch of salt water shrimp from the waters of the State of Louisiana during the calendar year of 1925 amounted to 65,333,375 pounds, as shown by the severance tax payments made to the Department of Conservation of Louisiana. Since there is sometimes a disposition on the part of certain persons or firms to evade the payment of such a tax, we feel certain that the catch during 1925 was somewhat larger than is shown by these figures. However, we have reason to believe that the amount of shrimp on which a severance tax was not paid was not very large, due to the efficiency with which our department has been able to enforce the laws regulating our salt water shrimp industry.

The greatest number of pounds of shrimp taken from Louisiana waters previous to 1925, was during the calendar year 1921 when the catch totaled 34,992,443 pounds, or 30,340,932 pounds less than in 1925.

According to the U. S. Bureau of Fisheries statistics, there were 94 canneries engaged in canning shrimp in the United States in 1924. Of these, 30 were located in Louisiana, 26 in Mississippi, 12 in Georgia, 9 in Florida, 7 in Alabama, 5 in Texas, 3 in North Carolina, 1 in South Carolina and 1 in New York. It is a well established fact that not less than 50 per cent of the shrimp canned in Mississippi are taken from Louisiana waters, and well informed authorities credit Louisiana with producing 60 per cent or more of the shrimp canned in that State. Taking 50 per cent as a basis, we will be absolutely safe in stating that 43 of the 94 plants which were canning shrimp, were operating on shrimp taken from the waters of our State. This, therefore, shows that Louisiana waters produce approximately 46 per cent of all of the shrimp taken from the coastal waters of all of the States of the Union. Using these same figures as a basis, the State of Louisiana produces approximately 63 per cent of all shrimp taken from the Gulf Coast waters.

The creditable condition of our salt water shrimp in-

dustry is, to a large extent, undoubtedly due to the excellent laws enacted for the control of this resource by our State Legislature, and the efficient manner of their enforcement. Two of the most salient features of this law are the liberal interpretation of what is defined as inside waters, and the extended close seasons covering such waters. The further facts; that this law authorizes our department to prohibit the using of trawls or seines for taking shrimp from the inside waters of this State at any time it may be determined by the department that their use is detrimental to the interest of the State and to the shrimp industry, and the fixing of the minimum size limit of shrimp which may be taken from our waters at four inches (4″) in length, measuring from the tip of the spear or rostrum to the end of the tail fan, and the regulation of the size of the mesh of seines and trawls at three-fourths (¾) inch square, all contribute greatly to the present excellent condition of our shrimp resource.

The question of enacting a law requiring that shrimp trawls and seines be made of netting having a mesh larger than is provided for in our present shrimp law, should, I believe, be very carefully considered by the authorities of all shrimp producing States. In the light of the knowledge we now have on this subject, we feel certain, that it would be wise to increase the legal size of the mesh of shrimp seines and trawls to not less than one inch (1″) square or two inches (2″) stretched. In fact, a few of our more prosperous and progressive shrimp fishermen have already been using netting having a mesh of this size and say that shrimp averaging a larger size are caught, with consequent much less destruction to small shrimp, indicating, therefore, a decided benefit to our shrimp resources.

It will probably interest the authorities of other shrimp producing States to know that at the 1926 session of our legislature more extended close seasons were provided, covering both the inside and outside waters of the State, and the same law forbids having shrimp in one's possession within the State, for either canning or drying purposes during these close seasons, even though caught from waters outside of the jurisdiction of the State.

Under our 1926 law there are two close seasons for all inside waters, one extending from December 1st to March 15th, both dates inclusive, and the other from June 15th to August 15th, both dates inclusive. In 1924, the winter

close season for inside waters extended from December 1st to March 1st only and the summer close season from June 15th to August 15th. Our present 1926 law provides two close seasons covering our outside waters; the first extending from February 1st to March 15th, both dates inclusive, and the second from June 15th to August 15th, both dates inclusive. Our 1924 law made but one close season covering our outside waters, and this extended from June 15th to August 15th, both dates inclusive. Again our 1924 law permitted the transportation of shrimp through our State during this close season if caught from waters beyond the jurisdiction of the State.

Our investigations show that a very large quantity of shrimp measuring three inches (3″) in length are found in our waters all through December, January, February and early in March; and that a large quantity of two and three inch shrimp are found in the waters of Louisiana during June, July, August and September. Therefore, it appears that we might profitably extend our summer close season to include the period from August 16th to September 30th, at least; this latter applying especially to our inside waters.

Several of the members who attended the meetings of the International Association of Game, Fish and Conservation Commissioners, and the American Fisheries Society, held in Mobile, Ala., September 20th to 24th, 1926, inclusive, will undoubtedly remember that while informally discussing shrimp matters with them, I remarked that the hurricane raging there on September 20th and 21st, would almost certainly have the effect of driving shrimp from many localities where they were found in abundance before the storm, into others where they were then very scarce, and that such instances were very noticable after the August 25th 1926 hurricane which hit a considerable portion of Louisiana's Gulf Coast. It may not be amiss to add here that after the September storm, shrimp were found to be very scarce in most Louisiana waters where they were plentiful before, and that good catches were being made along the Mississippi and Alabama Coasts in localities where such catches were very unusual. What causes these extraordinary migrations, probably find their answer in the unprecedented tidal movements which accompany these storms, but it will take further research before we can clearly analyze the various contributory factors.

Discussion.

MR. QUINN: There are just one or two matters of information I want to get from Mr. Tulian, because he is recognized as the authority along the gulf coast in reference to shrimps. Is there any economic reason for protecting outside shrimping during the close season?

MR. TULIAN: I do not think there is, any more than that you cannot enforce a law which allows them to go beyond the three mile limit; they will catch them inside the three mile limit, therefore we close them down more particularly on that account. But we cannot prevent them from going outside and taking shrimp; they have a legal right to go and take them from our people or anybody else. They are taken in for local consumption and domestic purposes. Our close season does not apply to shrimp consumed locally or sold in our fresh markets.

MR. QUINN: How do you mark your three mile limit? Can you establish to the satisfaction of the courts where the three mile limit is?

MR. TULIAN: We cannot do that. We have a sort of jumbled up proposition in that respect. But our instructions to all our patrol boat captains and inspectors is not to attempt to split hairs. Our inside waters are very well defined by law; they comprise all waters in which the tide ebbs and flows, and all the bays and everything up along the shores.

MR. QUINN: We have a close season from May 15th to August 15th on shrimp in Alabama. At a meeting last week, however, with the packers we have decided to ask the legislature to shorten that period by fifteen days on both ends.

MR. TULIAN: The first end may be all right; I do not know about the latter. Of course your conditions are probably different from ours.

MR. QUINN: We got a very fine catch of shrimp during May of last year, but they were full of spawn. We find, too, that by opening up shrimping on August 1st we get too many small shrimps.

MR. TULIAN: They grow pretty fast. Of course our law takes it up until the 15th of August, but as I said before we might profitably extend that to September 30th.

MR. QUINN: You say that you prohibit the shipping of unculled shrimp out of your State. The Alabama law has been prohibiting that all along. I am wondering if that law is not made largely in the interests of the packer.

MR. TULIAN: No, I do not think so; it is really made to conserve the stuff and keep it at home. Formerly these small packers threw away the heads and hulls, thus polluting the water and making a great waste. Under the new law they cannot do that; they must equip their plant for handling them. That stuff is too valuable to be thrown away, it should be utilized.

MR. QUINN: The Alabama statute prohibits the shipment or receiving for shipment outside the state of any raw shrimp.

MR. TULIAN: I think your law is a good one.

MR. QUINN: But I have often wondered whether that was not made largely in the interests of the packer. There is quite a spread between what the folks up north pay—$20 a barrel—and what the fellow pays for his shrimp down here.

MR. TULIAN: The main point is to ship them good stuff in sanitary condition, which we did not do last year.

PRESIDENT HAYFORD: It seems that in Louisiana and in other southern states this so-called shrimp bran is worked into what makes a valuable fertilizer?

MR. TULIAN: Yes sir, it can be used for other purposes, too—fish food, for instance. Just on that point, may I ask the President if he has noticed that in feeding the shrimp it colored the flesh of his trout a little?

PRESIDENT HAYFORD: Yes, we get coloration there, but it stops fin nipping. I have a paper here which I do not know whether or not I will read, but it makes reference to that point. You can feed the straight meat diet in one pond and five to ten per cent shrimp bran in the pond alongside, and in the pond where you feed the shrimp, after the trout are three or four inches long they have a better color and their fins are practically perfect; there is very little nipping if you do not overcrowd.

MR. TULIAN: When I had charge of the fish cultural work of the Argentine Government we used to buy quite a lot of eggs from England, from Germany and other parts of Europe, and in that connection I had occasion to visit a great many of the hatcheries over there. There is a hatchery owned by the Earl of Denby where they can color the meat of the fish to suit their customer's requirements; in other words, they can produce a white meat, a pink, or pretty nearly red, by feeding different foods. The red flesh came mostly from the fresh water shrimp food. I have seen trout taken from two small streams that were not more than half a mile apart—brook trout—one of which was absolutely white and the other pink.

PRESIDENT HAYFORD: Some years ago one objection the sportsmen had to our putting out these fish was that they were inclined to be soft, and by working the shrimp in we have brought the flesh to a firm condition.

MR. VIOSCA: May I ask Mr. Quinn where these shrimp were caught that he said were adult shrimp?

MR. QUINN: What season do you have reference to?

MR. VIOSCA: You said in the summer season, I think—that the shrimp were all spawning when they were caught.

MR. QUINN: They were caught in Alabama waters, and after May 15th they were caught from the outside. There were many of them fully spawned, so the factories all reported to me.

MR. VIOSCA: They were in the gulf, not in the bay?

MR. QUINN: Some were in the bay and some on the outside, in the gulf.

MR. VIOSCA: In our bays the adult shrimp never come inside what we call the shore line. I have never seen any inside.

MR. QUINN: I do not know if these were spawning, but they were full of spawn at the time they were caught.

MR. VIOSCA: Shrimp full of spawn is what I mean. In further elaboration of the statement made by Mr. Tulian I may say a word or two. He is not inclined to believe that it is of any economic value to attempt to preserve outside shrimp. It is usually too rough in the gulf to catch shrimp; possibly that is the case during about two-thirds of the year. In other words, we ought to have about an eight months close season. The further out you go, the more adult shrimp you get, and as you go out into the sea it becomes more impracticable to catch them because of the deeper water; they do not school up as much as they do in places close to the shore where the food is concentrated, and also because of the fact that in the deeper water there is a great abundance of sharks. It is almost impossible during the summer months to get a trawl of shrimp on your boat without having four or five holes bitten in the bottom of it by sharks.

MR. QUINN: In Alabama waters we get shrimp every year from the inside, eleven to fourteen of which will weigh a pound. That is a pretty good sized shrimp.

MR. VIOSCA: You are not sure whether they are shrimp going out to sea which have just reached maturity?

MR. QUINN: No, but we catch a lot of small shrimp on the inside which are an inch to an inch and a half long.

MR. VIOSCA: The adult shrimp, once it goes to sea, never comes back to the inside waters. But I do not know the depth of your bay, or whether it has enough of this sea water to allow the adult shrimp to come in.

MR. QUINN: Our inside shrimping grounds are not very deep—four to six fathoms, on the average.

MR. VIOSCA: That seems to be very similar to ours.

MR. QUINN: On the outside we get from twenty to forty fathoms sometimes.

RECLAMATION OF FOOD FISHES AND MUSSEL PROPAGATION

By C. F. Culler.

District Supervisor, U. S. Bureau of Fisheries.

In giving this resume of the rescue work that is conducted by the U. S. Bureau of Fisheries in the Upper Mississippi River Valley, the intention is to give as nearly as possible a comprehensive account of these operations that mean the saving of the fish in the Mississippi Valley, provided that some action is taken in the near future by the several states on pollution, drainage, and deforestation problems.

While I am not a pessimist, I make the prophecy that unless something is done, and that very shortly, the fishing in the Mississippi River will be only a memory. This too will mean that the folks who are now receiving fish from either the Conservation Commissions of the several states or the Federal Bureau of Fisheries will have to look elsewhere for fish with which to stock their lakes and streams, and where else can they be had? There is no other place in the United States where fish for stocking purposes can be had in such numbers, and the few fish they may receive, if this supply is not kept up, will necessarily have to be hatched and reared in control ponds.

The rescue work, as it is commonly known, and which to me seems a proper term, is conducted in that section between Prescott, Wisconsin, and Montpelier, Iowa, although the past season the section between Prescott and Lake Pepin was reserved by the state of Minnesota, and that from La Crosse to four miles below Genoa, Wisconsin, by the Conservation Commission of Wisconsin.

Perhaps no branch of the fish-cultural activities of the Bureau of Fisheries has developed more rapidly within recent years than has the purely conservation work of rescuing valuable food and game fishes from the temporary waters bordering the overflowed lands along the Mississippi River and the mussel infection operations connected therewith. The efficiency of the methods pursued in this work are clearly manifested, not only by the increasing numbers of food and game fishes rescued each season and the growing abundance of juvenile mussels in the various rivers of the Mississippi River Basin, but also by a marked decrease in the cost of the operations.

During the calendar year 1925, 149,830,999 fish were

rescued, at an average cost of $.142 per thousand, and 2,803,625,100 mussels, in a state of parasitism on rescued fishes, were liberated, at a cost of $.00144 per thousand. The economic value and importance of the rescue and mussel infection work to the Mississippi River Valley, its simplicity, and the comparatively small outlay of funds involved in its execution should be a matter of interest to every commercial fisherman, clammer, button manufacturer, and angler in the United States.

Normally the Mississippi River is a wide, shallow stream, flowing peacefully within its banks, but during the period of melting snows and heavy spring rains thousands of acres of bottom land and islands along its course are inundated. Scattered throughout these lowlands are numerous lakes, sloughs, and small ponds, which, during low water stages —from June to December—are entirely cut off from the main channel, but when the river overflows they provide ideal spawning and feeding grounds for all species of fish indigenous to the region. It can be stated with assurance that the territory between St. Paul, Minnesota, and Rock Island, Illinois, is the greatest natural hatchery in the United States for the various species of warm-water fishes. All conditions here are favorable to spawning and to the development of the eggs, and the young fish increase in size rapidly before the freshets subside. As the waters gradually recede most of the adult fish find their way back into the main river channel, but the young are not actuated to seek safety so promptly, and enormous numbers of them are finally cut off from access to the river. The lakes and sloughs left by the falling waters are of various sizes and depths, and some of them become dry in a few days or weeks. Others do not dry up entirely in the course of the summer but through the agency of seepage and evaporation become so shallow that the fish left in them are frozen during the succeeding winter. All of the shallower pools freeze to the bottom in cold weather and in the deeper ones large numbers of fish are concentrated within such a small area that death from smothering is certain, even if the pools do not freeze solidly.

From these lakes, sloughs, and pools many millions of fishes, embracing all of the warm-water species found in the Mississippi River, are collected by rescue crews and either transferred to the main channel of the river or to sloughs of running water. A very small percentage of these rescued fishes is transferred to holding stations for general distribution. When the fish are first taken from

the warm water of the shallow pools, the temperature of which has been known to reach 98 degrees Fahrenheit, they cannot successfully withstand a long railway journey. Because of this the fishes intended for general distribution throughout the country are taken to the nearest holding station and hardened, by holding them in cool running water for several days. They are then placed in cans and transferred, by means of the Bureau's messengers or distribution cars, to various points for use in stocking lakes, ponds, and rivers, which, owing to excessive fishing or some other cause, have become depleted of fish life.

Because of varying natural conditions, the stage of the water, or the prevailing weather, all of these lakes and sloughs are not equally prolific, some yielding only a few thousand fish, while from others immense quantities are secured. To give an idea of the possible returns in this territory, from the large bottom country near Bellevue, Iowa, which forms into three large shallow ponds after the receding of the waters in the spring, 4,284,813 miscellaneous fishes were rescued during one week the past season by two crews of men, the predominating numbers consisting of such commercial species as the carp, buffalofish, and catfish. In the course of the same season 150,000,000 fish were rescued in the territory lying between Reed's Landing, Minnesota, on the north, and Montpelier, Iowa, on the south. Of this number 939,614, representing sixty-two one hundredths of one per cent of the aggregate returns for the season, were used for stocking purposes, many of the waters in which plants were made being directly connected with the Mississippi River drainage system.

The low cost of the rescue work is considered especially noteworthy. It is estimated that the average cost of producing warm-water fishes at a pond station will approximate $5.50 per thousand. Yet the same species of fish were handled in the rescue fields last season at a cost of only $.142 per thousand.

The value of the rescue operations is quite generally recognized and commented upon by all who are familiar with the fisheries of the Mississippi River basin, and letters are constantly being received from fishermen and anglers, advising of increases in the fish supply in certain localities and the reappearence of species that had long been missing.

A rescue crew usually consists of a foreman and six helpers. A launch is employed in going to and from the field of operations, and the field equipment consists of ¼ inch mesh seines, six feet deep, ranging in length from one hundred twenty-five to five hundred feet, six galvanized

iron tubs of one and one-half bushels capacity, several small hand or dip nets, two one-quart tin dippers, and a small flatboat, for laying out the seines in ponds too deep for wading. After a haul has been made and the fish trapped they are assorted into tubs according to size and species. The fishes suitable for the purpose are then infected with larval mussels, carried to running water, and released. As often as may be necessary an actual count is made by the foreman of a rescue crew, to determine the average number of fish per tub, and as the season advances and the fish increase in size this counting has to be resorted to more frequently, in order to keep an accurate record of the fishes handled.

The need for this salvage work has long been recognized, but it is only within recent years that it has approached a point at all commensurate with the demands, or with the possibilities. Until the recent provision by Congress of a special personnel for the conduct of the rescue work, employees had to be detailed each season from various established stations of the Bureau thus imposing a hardship on those stations and also handicapping the rescue operations, by having to utilize the services of men unfamiliar with the conditions encountered. Lack of funds and untrained help have proven very disadvantageous in the conduct of the work in past years. Quite recently Congress was prevailed upon to provide a suitable personnel for the purpose, but ample funds to properly cover the cost of the operations are still lacking.

Among the many fishes rescued are large numbers that are suitable hosts for larval mussels, and these are infected with the glochidia or baby mussels of the commercial varieties of this mollusk, the mussels being released on the gills of the fishes as parasites. In this way a double service is accomplished, the infection being done in connection with the rescue operations, and at a very slight increase in cost, the same men performing both functions.

The primary object of the infection work is the maintenance of the pearl button industry, which industry is dependent on the mussels of the Mississippi River and its tributaries for almost its entire supply of raw material. There is probably not a person in the United States today whose clothing is not equipped with buttons manufactured from the Mississippi River mussels. There is no other known material so suitable for buttons of this type as the freshwater mussels, and for this reason the maintenance of the supply is of general interest.

Under natural conditions the mother mussel liberates her

young when her gill-pouches become filled and ripened, the little mussels passing out into the water with no predetermined destination. If a suitable fish, or host, as it is called, happens to swim in the immediate vicinity, the little organism is drawn through its gill-openings with the water taken in breathing and attaches itself to the gill surface. Here it remains until it has reached the stage where it can drop off and start an independent existence on the river bottom, a period varying in length from two weeks to several months, according to the water temperature, the higher the temperature the shorter the period. If there is no suitable host to which the larval mussels can attach themselves they soon fall to the bottom of the river and perish. This seemingly haphazard and uncertain reproductive method of Mother Nature is remedied to some extent by artificial infection, and as nearly all species of game fishes handled in the rescue operations are suitable hosts, it is a simple matter to infect them with the commercial mussel glochidia previous to liberating them in running water.

The artificial infection of fish with freshwater mussels has proven its usefulness beyond question. It has been definitely shown that practical mussel infection work can be made to yield material results by the experiments on Lake Pepin, which were extended over a period of years. An increase of 28 to 62 per cent in the number of Lake Pepin muckets (L. luteola) has been brought about in this lake within the past six years, during which time the mussel beds in the lake have been worked continuously by open clamming. On the White River and the Black River, in Arkansas, the yellow sandshell has also shown an appreciable increase, this result being brought about by work done under the direction of the U. S. Biological Station at Fairport, Iowa. In this connection it should be emphasized that it was at this station and under the direction of Dr. R. E. Coker that the artificial propagation of mussels became an established fact.

Without fish there can be no mussels, without water there can be no fish, and without forests and swamps there can be no streams suitable for fish, mussels, or other animal or plant life. Unless measures are taken to protect the river bottoms and swamp areas from ill-advised drainage it will be only a short time until the Mississippi River and its tributaries will serve as nothing more than sewers for the cities along their banks. This would mean the eventual destruction of all forms of animal and plant life in the streams of the Mississippi River drainage, which at the

present time constitutes the greatest natural hatchery in the United States for warm-water fishes. It would mean the extinction of all the fishes sought after by the commercial fisherman and the angler, and would also wipe out the fresh-water mussels. The complete extinction of our aquatic resources will be brought about within a short time, unless prompt measures are taken to prevent it.

For years past no attention has been given to law-enforcement or to measures looking toward the conservation of our fishes, mussels, and other aquatic life, and there has been a very apparent lack of cooperation on the part of all, which has tended toward a lack of respect for the laws and for conservation in general. The question of conserving all forms of aquatic life should be considered a national rather than a local one, as aquatic life enters largely into our food supply, and from a recreational point of view is of interest to practically everyone. The average man is a law observer, but when fishing he often loses sight of the laws and of the rights of others, and proceeds on the basis that the fish are his own individual property. It is surprising to observe the extent to which this feeling has affected the aquatic resources throughout the country, and until it can be corrected and each and every man impressed with the fact that laws are enacted for the benefit of all collectively, we cannot expect any material increase in our aquatic resources, no matter how much may be accomplished by various conservation organizations, rescue operations or artificial propagation and general conservation work.

Discussion.

MR. VIOSCA: In Louisiana we have several million acres of swamp and marsh lands and more than that amount of unused well drained uplands and river bottoms. I do not see the sense in draining a single acre of marsh lands in our state until we use up all our uplands and river bottoms which have already been drained. Our department has recognized the relationship between mosquito control, which is believed in some parts to be only a health problem, and the conservation of our fishes. We have already dealt in a paper with the engineering aspect of the subject and I shall be glad to send copies to members of the Society who are interested in the relationshp of mosquito control to fish preservation and things of that kind.

MR. CULLER: The pollution problem on the Upper Mississippi is the most serious one we have to contend with. A bacteriological examination was made of the water at the high dam in Minneapolis last fall, and the bacterial content was found to run 475,000 per ccm.

IS THE GENERAL PLAN OF STOCKING WITH FINGERLINGS IN THICKLY POPULATED SECTIONS WORTH WHILE?

By Charles O. Hayford.

Superintendent State Fish Hatchery, Hackettstown, N. J.

Each year the New Jersey Fish and Game Commission has released in our larger streams a large number of rainbow, brown and brook trout above a six inch size, the legal limit,—rainbow and brown trout predominating. These fish until four years ago were mostly distributed in the spring during the trout season, and were regarded as "fillers", in the sense that they supplied immediate sport while the fingerlings planted in previous years in much greater numbers were developing.

There was a growing belief on the part of the Commission and the anglers, strengthened by experience during the fishing season that, instead of being a "filler" the large fish planted afforded practically all the fishing. In other words, it was a question with us whether or not the policy of planting small fingerlings was really worth while. Did enough of them mature to affect the fishing?

In the fiscal year ending June 30th, 1920 more than 800,000 trout under the legal limit were distributed in 900 miles of New Jersey streams. In the spring of 1921 nearly 400,000 brown trout fingerlings and over 900,000 brook trout fingerlings were planted. A great majority of the 1920 and a large part of the early 1921 distribution should have reached a catchable size by the 1922 season, providing they escaped the many enemies that beset the young fish.

If the system of planting fingerlings is worth while, the seasons of 1922 and 1923 should have been the best on record, for there were practically 2,000,000 fingerlings distributed not counting the late season plants.

How many of those fish survive to reach the angler's hook? Of course this is a question no one can accurately answer but the fishing in 1922 and 1923 was not up to expectations. If no large fish had been planted in 1922 and 1923, according to our check-up, there would not have been worth while fishing. One makes no guess when he says that trout fishing under our conditions, is good or poor according to the number of large fish liberated during the season. That is obvious. The stocking with big fish shows

definite results. The planting of fingerlings may or may not produce good fishing. The one is absolutely essential and certain; the other is almost entirely experimental. New Jersey waters cannot be compared with the Adirondack streams or the remote New England sections for the planting of fingerlings.

There is not the least doubt that the average angler would rather hear that a stream had been stocked with 8 to 12 inch trout than with fingerlings. The big fish are there and can give a real account of themselves. The little fellow at best represents only a possibility of future sport. It will be a long time before he is able to give an account of himself at the end of a line. If he gets through this year he will have a hard time next year. The ruthless hook torn out of his mouth by a dry hand is not his only foe.

Therefore, after years of experimentation with fingerlings we have decided the logical course is to stock with large fish, except in case of certain suitable streams which have plenty of cover. Against such a plan may be raised the argument of greater cost and the danger of disease wiping out the work of years. It is, of course, less expensive and the reports seem more impressive, when large numbers of small fish are put out. But when the success of stocking is measured by the angler's catch the results are not so impressive. Commercial hatcheries are taking the risk and the State forces should be just as efficient.

It is not my intention to start a discussion in regard to fingerlings vs. fry as that was barred many years ago.

New Jersey is a State of small area and very thickly populated. With improved roads parallel to or crossing our best trout streams practically every stream in the State is within a two or three hour run from one-seventh of the entire population of the United States. You can readily grasp our situation. Just as soon as a stream is producing good fishing, it is given a great deal of publicity by the New Jersey, New York and Philadelphia papers.

From 1918 to 1922 the hatchery office mapped and indexed all the streams of New Jersey according to information furnished by the biologists and wardens with the result that any stenographer can quickly make up the distribution list with a few instructions from either the chief warden or the fish culturist.

Our biological survey brought out many interesting points in regard to the stocking of the 664 miles of the smaller trout streams with fingerling trout 3 to 4 inches long. Many of these small streams produce results, but I am frank

in stating I would rather plant 100,000, 8 to 12 inch fish in these small streams than the 1,000,000, 3 to 4 inch fingerlings we are now planting.

I will give you two illustrations. First, in one of these small streams we planted 10,000, 3 to 5 inch healthy fingerlings. The following spring in four miles of this stream I can safely say that they did not catch 100 legal trout. The warden's report on this stream stocked the following year with 500, 8 to 12 inch trout showed a catch of over 400 trout the first week of the fishing season. Second, during the 1925 trout season I studied six miles of trout stream controlled by private owners, which had not been stocked by the Commission for a number of years. On the first trip to this stream I caught one brook trout, my partner caught one brook and one brown trout, the other two fishermen caught nothing. The second trip I caught nothing, my partner caught one brown trout. On my third trip I caught one brown and one brook trout, my partner got one brown trout.

The various people owning the above mentioned stretch of water did not care to stock it at their own expense and it was too expensive for a club proposition. After a number of friendly talks they turned the stream over to the sportsmen. On seven trips to this stream, this past season, I caught ninety-six trout 8 to 12 inches long. All other fishermen were getting from 6 to 15 trout per day.

Beginning March 15th we distributed a truck load of 8 to 12 inch trout in this stream each week until June 15th. Some weeks when the stream was heavily fished we had an extra load put in. This stream is teeming with small minnows and aquatic insects.

The superintendent of fish culture in our State has charge of all hatchery construction and propagation. When fish should be planted, he furnishes the chief warden with a list that is turned over to the assistant warden in charge of transportation of fish and game. We have found this system very satisfactory. The chief warden, assistant chief warden and superintendent of fish culture have always cooperated.

The chief warden has one or more salaried representatives in each county who keep him posted at all times as to fish and game conditions, newly posted areas, pollution, etc. As fast as he receives this information, it is forwarded to the hatchery office where the survey card is brought up to date.

In case of a new warden he is furnished with a map show-

ing the streams and their locations and during his first year we send a man on the truck who is familiar with the stocking conditions to assist him.

For transportation of fish to the streams we have five trucks with pneumatic tires equipped with large portable tanks. In addition, each warden is furnished with a patrol car and tanks to assist the big trucks in scattering fish and game.

Our total stream length is 2840 miles. Of this amount there are 641 miles of stream between 30 and 50 feet wide known as rivers and large trout streams. Out of this 641 miles, there are sections amounting to 300 miles adapted to the planting of 8 to 12 inch rainbow, brook and brown trout; the balance of waters is made up of shallow riffles, mill ponds, lakes, etc. All of these lake and pond sections are infested with pickerel and bass which are fed into these streams by the different waters.

Three years ago after many years of experience with 3 to 4 inch fingerlings, we adopted a system of planting in these large streams, trout 8 to 12 inches long. At first we planted about 100,000 of these large fish annually. During the past three years we have enlarged our hatchery to the extent, that we planted 250,000 or more of these large fish each year. The Commission and sportsmen are so well satisfied with this policy that the department now has negotiations nearly completed for the construction of an auxiliary hatchery which will contain nothing but rearing ponds for the raising of 200,000 to 250,000 large fish. This will give us an annual output of between 400,000 and 500,000, 8 to 12 inch fish.

In conclusion I will say that one of the most popular things we do in our State is to furnish the press, each year before the trout season opens, with a list of all the streams giving location, species, size and number of fish that have been distributed since the close of the last trout season. I would further say, that if the fish are there as reported you will continue to get favorable newspaper publicity; if not, you will receive any number of letters and phone calls from the sportsmen telling you what they think of you.

Discussion.

MR. LAIRD: What method does Mr. Hayford use in transporting his fish?

MR. HAYFORD: We have five ton and a half to two ton trucks on pneumatic tires, equipped with portable tanks six feet long, four feet

high and two feet wide, with a four to six inch flange around the edge to keep the water from splashing out.

MR. LAIRD: Do you use any aerating device on it?

MR. HAYFORD: No. These trucks run from twenty to thirty miles an hour. New Jersey is a small state; there is only one county that we cannot reach in less than five hours.

MR. LAIRD: One man on Long Island built a tank on a truck, with an arrangement to promote the circulation of the water; he puts a small engine and a pump on this truck, aerates the water, and will carry a thousand fish a couple of hundred miles at a cost of twenty-five cents a mile. He can transport an immense quantity of fish at little cost.

THE CHAIRMAN: You mean twenty-five cents a mile as the running expense of the truck, including the pump?

MR. LAIRD: Yes, twenty-five cents a mile is what he charges for carting fish anywhere.

DR. EMMELINE MOORE: I would like to ask Mr. Hayford if this policy he has adopted of distributing large fish will eventually mean that no fingerling fish will be distributed from his hatchery?

MR. HAYFORD: No. We always count on hatching more fingerlings than we use. If in this program of larger fish distribution we figured that we needed 2,000,000 fingerlings, we would hatch 3,000,000; we would try to protect ourselves to the extent of a reserve of about 33-1/3 per cent. After we have got those fish up to three or four inches we plant them in 600 miles, more or less, of small mountain streams that are feeders to the big streams. We may have years that we won't be able to plant any, but once you start this program there is no turning back; when you have put a lot of these big fish in the streams and then send them a few little ones, the sportsmen are not interested and they take the matter up quickly. That is why we are building these large ponds and looking after all the little details—cleaning and turning them over; disinfecting, using chloride of lime, and so on; the treatment of parasites, to keep down the various enemies—you have got to use a microscope about every day.

THE CHAIRMAN: Do you close these 600 miles of mountain stream which you stock with fingerlings?

MR. HAYFORD: No, we cannot close a stream in New Jersey. We have an enormous number of water snakes in these streams. I have been along a stream with a rifle or shotgun and within a distance three times the length of this room have killed seven of them, all with trout in them. I opened three at one time and found that one had eleven, the other nine, and the other fourteen or fifteen.

I do not care whether you are in Alabama, or elsewhere, you have got to get results. If you can get them with the two inch fish, all right; if not, there is no sense wasting your money for the sake of filling up a lot of paper with reports. One fish culturist came there

and said I was all wrong—I am not going to mention any names, but he is soon going to adopt the policy himself as applied to thickly populated sections. Those men who can jump into their car at three o'clock and in anywhere from three-quarters of an hour to two hours get to a stream where they can catch half a dozen of these trout will vote for the whole program. They will put it through; you do not have to. In fact, you have to hold them back; they want more than you can give them.

MR. LEACH: I would like to ask the opinion of Mr. Titcomb and Mr. Hayford in regard to the introduction of rainbow trout in the coast streams of New Jersey and Connecticut. In many places where we plant rainbow trout throughout the southeastern sections of United States we find that they run out of the streams and possibly into the ocean; at any rate they leave the waters in which they are placed. It seems to be the nature of the rainbow trout to seek the larger waters. I was wondering to what extent your streams in New Jersey and Connecticut could be stocked with rainbows and also brown trout. Do you find that the brown trout crowds the brook trout in the headwaters of the streams?

MR. HAYFORD: Not over ten per cent of our so-called trout waters are really adapted to brook trout; with the load we have on our streams we cannot get the results. We plant brook trout and brown trout in the fall and we put in the rainbow right through the fishing season. We work as much as we can with the rainbow for the streams on which there are large mill ponds, because generally they will hold up when they strike these mill ponds. But if you put the rainbow in a stream with a drop of say three or four hundred feet from the mountains to the Delaware River, with nothing to stop them, when the water gets warm or low they will disappear.

THE CHAIRMAN: Do they breed naturally in these streams?

MR. HAYFORD: Yes, but we do not figure on natural reproduction there, with a quarter of a million fishing people operating in less than a thousand miles of stream. It is like a cafeteria; you have to get in line to get to the stream.

THE CHAIRMAN: Answering Mr. Leach's question for Connecticut and New England—and if Dr. Moore were not here I would include New York—I would say that the rainbow trout have been very generally introduced but have proved a failure in most instances. As far back as when Marshall McDonald was Commissioner—I think it was in 1891—I asked the question, what about the rainbow trout? He had been superintendent at Wytheville and was the man who introduced rainbow trout in eastern hatcheries. He replied immediately: "We have been sending rainbow trout to New York and New England for a number of years and they have almost always disappeared; we do not hear from them." I have many times verified that statement. We

have tried them in Vermont, and there may be one stream there to-day containing rainbows. They have been planted all over Connecticut, and there is only one stream there to-day I know of that has any rainbows in it, and these are rare. You find the same conditions in New Hampshire. In New York state, particularly in the Catskills, where the brown trout have been so generally introduced, rainbows were introduced as fingerlings in large numbers. The New York hatcheries have propagated rainbows for a great many years. In consultation with sportsmen of that region I made a canvas of the streams in the Catskills. We held a symposium on the subject. We took a topographical map and went right through these streams systematically. It would be brown, brown, brown, and occasionally a small brook trout stream, and then someone would exclaim, "Oh, that is a rainbow stream," nobody could tell why. All of these streams had been heavily stocked with rainbow. I am hoping some day somebody will go to one of these eastern streams to which the rainbow has been successfully acclimated, study the conditions and find out what there is in that particular stream that qualifies it for a rainbow stream, as against the ninety-nine per cent of other streams where the rainbows have been practically thrown away. I do not attempt to propagate them in Connecticut.

MR. LAIRD: On Long Island we have been planting rainbows in the brackish waters for years, and of the whole lot we put there we have not got one out of ten of them. They go out to sea, travel along the coast, and the fishermen get them.

DR. EMMELINE MOORE: We have found in our stream survey of the Genesee River this summer a section of the river in which the rainbows have become domiciled, apparently successfully, because the fingerlings were planted in years gone by in the Genesee tributaries. In this section where large rainbow trout are now caught, the streams leading into the river have apparently been rich in food, and they have migrated as larger fish into that portion of the Genesee which has been widened on account of the construction of a large dam, thus furnishing a larger range of deeper water for the rainbow into which they can migrate as they develop from the tributaries. We were very much interested to find that situation in the Genesee. It seems to us to be an exemple of a case in which rainbows, given the right conditions, may be domiciled in a stream.

MR. FOSTER: How large were the rainbows that you speak of?

DR. EMMELINE MOORE: I did not see them, but Dr. Embody was in close touch with those who caught them, and they were big fish.

MR. FOSTER: Two pounds?

DR. EMMELINE MOORE: They were more than two pounds. Of course the fingerlings only had been planted there, but they were evidently of a size to have reproduced several times.

MR. FOSTER: We have had fairly good success with the rainbow

in Missouri. Just what the reason is I am not prepared to say. Our streams more closely resemble those of which Dr. Moore has spoken; there are wide stretches and frequently quite long pools. Our policy with the exception of one stream, has been to plant fingerlings, and every year there are trout of over eight pounds taken—in fact, from eight to fourteen pounds. We think that the rainbow is a mighty good fish in the Ozarks, and it seems to stay with us. Of course we do not expect to catch every one that is put in.

THE CHAIRMAN: They seem to be very successful west of the Mississippi.

MR. LEACH: It seems to be the concensus of opinion that the rainbow will leave the streams unless everything is favorable. In the southern states, for instance, in the Carolinas, Tennessee and down through that country, they are what we call temperature locked; they cannot get to the sea on account of the high temperature prevailing between the mountain streams and the sea coast. That is about true with regard to the rainbows in Missouri. I do not think they would enter the Mississippi River; they would not leave the current of cold water in the streams in which they are now found and go into warmer waters. We have a great deal of trouble with applicants who want rainbows for every kind of stream, so that it is necessary for us to give very careful study to the matter, and sometimes to ask the states their opinion as to stocking certain streams within their boundaries with rainbow. For instance, not long ago, an applicant in Florida wanted rainbow for a certain stream in the northern section. He was a northern man and was used to rainbow in northern New York. He was decidedly of the opinion that the rainbow would thrive in this Florida stream. It got to the point where we had to refuse him, and to tell him that if he wanted to experiment with rainbows he would have to buy them.

THE CHAIRMAN: We shall always be glad to give you information on our waters whenever any question arises in connection with them.

MR. HAYFORD: We do not put out any rainbow trout that are not of catchable size. Ten years ago we discontinued the policy of planting rainbow under the legal size. One of the primary reasons we do raise them is because they will stand warmer water than the brook or the brown trout. We can run the brook or brown down to five or six ponds and then we can stick in a lake or two of the rainbow, but we do not use any of our waters to the detriment of the brook or brown. I would be in favor of switching practically all to brown trout, but we have a sentiment among the fly fishermen that is very partial towards the rainbow. We keep a check on them all the time and we know they are getting them.

MR. FOSTER: I understood Mr. Hayford to say that the brown trout will not stand as high a temperature as the rainbow.

MR. HAYFORD: Not with us. We never have any furunculosis among our rainbow trout, but when the temperature goes beyond 68 degrees we do get it with the brown trout.

MR. FOSTER: I was sorry that I had to miss a part of the meeting, owing to an indisposition, and I should like to be permitted to make a few remarks at this stage, Mr. President. In doing so I hope I shall not cover too many points that have already been dealt with.

One of the most serious problems of the lower Mississippi drainage is that of natural enemies. In the last year in Missouri we have been carrying on an active campaign in the destruction of turtles, gar, snakes—in fact, all the enemies which in many instances are directly responsible for the depletion of some of our finest sporting waters. In addition to that, we have been removing rough fish—carp and buffalo—from some of our lakes. I feel that this is quite as important work as the propagation of fish for stocking. It is useless to plant other large fish or fingerlings in waters which are literally teeming with enemies. On one occasion in the Gasconade River our men destroyed in one day 4,000 gar by dynamite, and local inhabitants carried them away by the wagon load and car load. Some of the gars destroyed weighed up to thirty-five pounds apiece. That is a thought for the southern members in their work. I have seen in the course of a few years the bass and crappie in waters well adapted to those fish, become almost extinct on account of the activities of their natural enemies.

Another matter for the consideration of the southern states is whether or not, with the numbers of bass and game fish which they have at the present time, it is advisable to advertise this fact and create a tourist business. There are two points to be considered, the advantages to your local sportsmen who are supporting your Department with finances, and the advantages to the state as a whole by the bringing in of new money and new thought from the north. If the southern states were to take advantage of the radio and up-to-date means of placing before the public the advantages of their fishing, there is little doubt that an enormous amount of the sporting business of Minnesota, Wisconsin, Maine and other states would be diverted to the south because of the larger size and numbers of our fish.

OPEN WATER FISH CULTURE

By H. L. Canfield.

U. S. Fisheries Station, Homer, Minn.

It is generally conceded that the fishes and other wild life belong to all of the people, and it is also conceded that the waters in which they live belong to the people. Since the early days of the Indian and his follower the white settler, the waters have been an established way of travel and a system of communication between peoples. The peoples own, to use as they elect. The waters of our country are widely distributed and they should be retained, guarded, protected and improved, and made accessible for the use and enjoyment of all for all time. Not only the waters alone, but the shore lines as well.

The State of Wisconsin declares itself on the people's waters in a manner worth general adoption. Their laws declare the State has ownership and control of all navigable waters within the State and define as "navigable" all waters in which a saw log may be floated, and do not put a size limit on saw logs. It is said this law was put through the legislature by some lumbermen of former days, but it now serves the people because their rights are outlined in the law, making it easy to handle the waters of the State as the people, their owners, may wish, without interference from any source. Would it not be well for all of the states to outline in their laws, as fully and clearly the people's rights regarding the waters.

The waters of our country are our most widely distributed recreation agencies, and their importance from a recreational and health standpoint is perhaps their greatest value to all of the people now, and will be of still greater value from this standpoint as time goes on, but the attraction to the waters is not only the waters and the scenic beauties of the waters and their shores, but the wild life that inhabit the waters and the fish therein, and the sport of hunting and fishing. The food value of the fish and the commercial value of the fish and other water products is also of great importance, but the most direct benefits will come to the greatest number of people as a result of the waters' recreational advantages, for "Health is wealth," and the out of doors brings health.

Pollution is a big subject in itself, so there will be no discussion here of waters from that standpoint, but this much

is certain, the people do not want their waters made into sewers to care for commercial wastes and filth, and fish cannot breed and mature under such conditions. There are many clean men now working on this filthy problem, so there is much hope that the waters now clean will be kept clean, and polluted waters cleansed in due time to the best interests of all.

Clean waters will produce fish, and clean waters improved and managed will produce MORE FISH. Not all of our waters are polluted, so the improvement and management of clean habitable waters may start now. Very little has been done in the past with the idea of improving the waters for the benefit of all, much less to make them produce fish, because in past the people have had no organized voice in the matter. It is not necessary to mention the things done which have injured the waters, and other injuries done the waters through exploitation to the profit of the few.

The improvement of waters primarily for fish production will consist of improving the aquatic plant and animal life of the waters, their swamp lands, and the vegetation of their shores and lowlands. The use of water for commercial purposes when beneficial to the fishes will be encouraged, and when against the best interests of the fishes, will be discouraged. The waters will be manipulated for the benefit of the fishes, and sloughs and lakes will be opened or closed at outlet or inlet as required, and reservoirs will be created where conditions favor. The waters will be controlled and handled where practicable, with the idea of working the waters to produce fish.

Destructive fishes will be held in check, and measures will be taken to maintain a working balance between food fishes and their required forage food with the idea of the production of desirable food fishes, rather than to allow the waters to continue in the old open range way.

There are few localities where a lake, pond, a section of the river or other waters cannot be taken in hand and improved to produce more fish. As a matter of fact there are few lakes or other controlled waters but what could be improved materially by taking an inventory of the fish population by means of nets or seines, then pursuing fishing with the idea of bringing about a proper balance of desirable fishes, and following this work by making a survey of the plant and animal life of the waters, and improving the forage food therein on the information obtained.

A certain lake in a mid-western state is overstocked with bullheads. Few persons fish for them, yet the bullheads

are consuming the food required by the desirable fishes. The desirable fishes are being fished for by summer visitors and a heavy local population, so with fishing and the help of the bullheads in a food competitive way, the desirable food fishes are being depleted from the lake

The Mississippi river is heavily fished for all species of desirable food fishes, but the most destructive fish in the river, the gar fish, is not fished for or otherwise controlled. The gar fish lives principally on fingerling fishes and it is a real menace in our waters, destroying great quantities of fishes daily. The commercial fishermen no longer take any number of them in their seines, because large mesh seines are used nowadays, and the fish being long and slender. for the most part passes through the meshes. The gar fish is largely an open water fish, and they are increasing rapidly and some measures must be taken to keep them within control in the interest of the fisheries. The Bureau of Fisheries hopes to be able to put them to some commercial use and thereby solve the problem, through creating a market for them.

The freshwater sheepshead have taken possession of many lakes to the detriment of the more desirable fishes, and the sheepshead become under lake conditions undesirable as food fishes in most cases.

The carp being a desirable commercial food fish is often controlled through commercial fishing; especially is this the case in northern waters where the states profit from the industry by exacting a few cents per pound from commercial fishermen, for each pound of carp removed under direction and supervision of a game warden.

In most of our waters the desirable fishes are removed by fishing and the undesirable fishes are left to increase and devour not only the food of the desirable fishes, but in many cases the eggs and the young of the desirable fishes as well. Little or no attempt has been made to maintain a balance of desirable fishes in open waters.

There are many sloughs, bayous, mill ponds, trout streams and other waters that may be improved by a little damming or opening to provide feeding and spawning grounds. Most any waters may be improved along the shore line by planting sedges, water weeds, grasses, willows or other plant life to attract food, provide shade and hold the banks in place.

The introduction of forage fishes and plant and animal life for the food benefit of the fishes is much needed in many waters. Lakes, ponds and other controlled waters

would profit particularly from such work. In some waters some of the plant life needs reducing or removing.

The work of improving the open waters will not be expensive if done by interested persons near the particular waters to be improved, and as the Federal and State fisheries and conservation agencies are well scattered about the country, their advice and guidance can readily be obtained from nearby headquarters. These agencies can easily and quickly outline the required steps in engineering, fish culture and biology to cover the particular case, so that the local help can go forward with the work.

A survey of our waters in most any locality will convince the most skeptical that there is need for improvement. We are raising quantities of fish in our hatcheries and ponds for stocking purposes, but too often the condition of the waters into which they are planted is so unsatisfactory that they are unable to support a reasonable fish population. That they may be improved and handled to produce and maintain more fish is certain.

The improvement and management of waters will require considerable work. Practical work based on scientific information, and the Fisheries and Conservation organizations should be called upon to demonstrate and advise in the work. Probably in some cases demonstration areas of improved and managed waters for fish production may be maintained to better explain and demonstrate to the local leaders especially designated to put through the work in their locality.

From what source will come the help for stream improvement? The problem is general and much help will be needed. Will the people get out and do the work? We think they will. The cooperative work the Bureau of Fisheries is doing, convinces us that the help awaits us, and that the people stand ready through their organizations to go forward with all constructive fisheries work, in many localities.

At no time in the history of the country have the people taken the interest in the out of doors and wild life that they are taking today. The automobile and good roads have shortened distances and the increased travel has awakened in the people an appreciation of the recreational and health advantages of the out of doors never dreamed of before. Witness the picknickers and campers everywhere, and the numerous tourists visiting our public parks and preserves, and those visiting the North woods in summer and the Southern out of doors in winter.

A certain outdoor organization, originated a few years

ago by men interested in the subject, has grown to be the largest outdoor organization in the world. Its officers receive no salary, but work for the good of the cause. Among these men are leaders of the country in business, journalism, science, and law, all contributing their time, money and efforts in a work they know to be for the good of the people. The slogan of this organization is, "Defender of Woods, Waters and Wild Life." Much of their work is done through Federal and State Fisheries and Conservation agencies, and their help may be depended upon for all constructive work in wild life which is of benefit to the people. The Upper Mississippi Wild Life Refuge, consisting of approximately 300 miles of river, lakes, islands and bottom lands, is one of the constructive things recently accomplished through this organization's efforts. We have many other good outdoor organizations with similar ideals.

The call for more fish in our waters at this time is almost universal, and the outdoor enthusiasts continue to increase by thousands annually. How are we to produce sufficient fish to supply the demand? The writer believes that the fish supply may be maintained and improved to meet the demand, only through the practice of fish culture in open waters in addition to the work of our hatcheries. This work may be done largely through outdoor organizations and the time is ripe to proceed, since the machinery is ready now, to put through the work.

Clean waters will produce fish. Clean waters improved and managed will produce more fish. The order is, "MORE FISH". Do you know a more certain way to fill the order?

MODERN METHODS OF FISH PLANTING

By David H. Madsen.

Fish and Game Commissioner, State of Utah.

This paper is not intended to be controversial in character. The opinions set forth with reference to the distribution of trout in Western waters are the result of more than twelve years' active participation in planting trout under all conditions encountered in my own State, which are, no doubt, typical of conditions to be encountered in practically all Western States.

The rapid change affecting the utilization of out door opportunities, must be met by artificial propagation. To illustrate my point: About thirty-five years ago Eastern Brook Trout were first introduced into Utah waters. A small plant consisting of some five or six thousand fry was placed in Fish Lake, a mountain lake seven miles long by a mile and one-half wide, located at an altitude of about 9,00C feet. Eighteen years later, the incident had been entirely forgotten and during that period not one single Eastern Brook had been taken from these waters. As a matter of fact, there is no record that anyone ever fished those waters during that period. It was then that some pioneer in outdoor development conceived the idea of hotel accommodations at the Lake, with boats and other conveniences.

I was employed to construct and deliver a motor boat to Fish Lake. The boat was twenty-three feet long with a nine foot beam, and probably weighed two thousand pounds. It required a six horse team and three day's time to transport the boat over forty miles of road. After the motor boat had been successfully launched, we repaired an old sunken row boat, the only one on the lake, and in company with a boy some eight or ten years of age, I went out and caught the first Eastern Brook Trout ever to be taken from these waters.

It developed that from the small beginning, these fish had increased so rapidly that the Lake was fairly alive with them, but it required another six or eight years before the place became popular. During that period it could only be reached by horse and wagon and consequently the drain on the fish was unimportant.

On the 24th day of July this year, five thousand people were camped or housed in hotels and cabins around the lake. Two hundred boats were operating there. A fine

automobile road has been constructed to the lake and a checking machine to register automobiles will probably show at the end of this season that ten or fifteen thousand automobiles will have visited the lake. This development has occured during the last decade and what is true of Fish Lake in Utah is true of practically all Western waters, and is perhaps also true of all the good trout streams in America.

The time is past when the introduction of a few cans of fish will bring about conditions such as have been described. Today, the problem is that trout fishing depends upon production and distribution of the fish which the sportsmen are to catch. There are a few exceptions to this, but it will generally apply. The old controversy as to the value of fry versus fingerling for stocking purposes will receive only brief mention.

The attitude of the State of Utah is that the planting of trout fry has little or no value, except in certain waters where there is an absence of large fish and an abundance of fish foods suitable for the subsistence of fry during the period immediately following their planting. Our effort will be to plant fish from three to seven inches in length that have been held in rearing ponds not less than six months, nor more than twelve months.

Padding of figures setting forth the number of fish which have been planted will not be tolerated. Our contention is that artificial propagation and the distribution of trout under strictly scientific methods is eminently successful and that the chief reasons for the rather general complaint that our methods are not successful are: The desirability on the part of the game departments to get favorable advertising by publishing unwarranted figures and because of the slip-shod, unscientific method of distribution.

Fishing can be improved and the needs of the sportsmen can be met by honest, sensible, constructive effort and any other policy is short-sighted and will react unfavorably against the profession. The idea of turning over to sportsmen and sportsmen's organizations the output of State hatcheries to be planted according to the whims of untrained men in order to satisfy the local demand, is not sound and will not produce results. It is a shameful waste of public funds to collect eggs, hatch them, and place the fry in the hands of men, well intentioned and zealous in conservation work, but who by the very nature of things, cannot possibly be qualified to properly distribute them. The cooperation of sportsmen's clubs should be encouraged, but the Game Departments can best avail themselves of such

cooperation by accepting assistance, financially and otherwise, at the same time keeping in direct charge of operations a trained personnel.

Our Department has constructed in connection with each of its eight fish hatcheries, adequate rearing ponds for the purpose of bringing fish up to the required size and no fish are distributed direct from the hatchery. In the rearing ponds, in addition to the artificial feeding, the small fish have the opportunity of developing their natural instinct by surface feeding to such an extent that when liberated in waters where there is surface food, they immediately proceed to take care of themselves. In numerous instances, I have observed fish four inches long taking insects from the surface thirty minutes after planting.

By following this policy we have produced good fishing in waters which have been adequately stocked, while in waters which we have been unable to reach, or where our funds would not permit us to plant a sufficient number of large fingerling fish, the sport has all but disappeared.

The great bulk of fish which results from this method has presented a serious problem of distribution and much experimenting has been done, as to the best and cheapest method of delivering this large volume of fish to the proper lakes and streams. The old method of distribution by railroad cars and trucks, where cans are used to carry the fish, is obsolete, and the expense of delivering the required amount of fish of the proper size to the stream by such methods, is so expensive as to render it almost prohibitive. During the past three years, we have applied a well known method of aerating water, for the purpose of carrying fish. The result has been two tank trucks constructed along lines as follows:

We purchased two Buick, 1926, Model 50, touring car chassis. The hood, fenders, shroud and instrument board were standard equipment. The wheels were changed so as to use 33″ x 5″ high pressure, bus type cord tires. A special roadster seat with about the same leg room and driving position as is found in the front seat of a standard touring car, was built, together with a light bow top, storm curtains, etc. A steel tank, 38 inches in width, 56 inches long and 32 inches high, was constructed from 16 gauge steel, welded seams and reinforced with one inch angle iron. This tank has two removable baffle plates to prevent too violent agitation of the water. The tank was mounted upon the chassis frame immediately behind the driver's seat, its bottom being protected from exhaust gas heat by a sheet of ¼″ abestos

and a thickness of ¼" pine sheeting. The mounting of the tank directly upon the frame gives the load a very low center of gravity.

Near the right front corner of the tank, and directly in front of the right rear fender, a small, two cylinder air compressor (such as is used in garages) was installed. Upon the left side of the tank, and directly in front of the left rear fender (the tank itself rests between the rear fenders) and attached to the tank itself, was constructed from 16 gauge steel an air cooling tank containing a 35 foot coil of ⅜" copper pipe. The cooling tank is two feet long by two feet high by 10 inches in width.

Power with which to operate the air compressor is obtained in the following manner: A hole is cut in the right side of the transmission gear housing and a small gear housing attached thereto. This small housing is equipped with a sliding gear and shaft together with a shifting fork and shift lever. This sliding gear engages and disengages a gear upon the counter shaft in the transmission gear set. Upon the end of the shaft is mounted a motorcycle sprocket and power is transmitted thereby, by means of a motorcycle chain, to a jack-shaft which was attached to brackets mounted upon the right side frame member of the chassis. From this jack-shaft the power is transmitted to the air compressor by means of motorcycle sprockets and chains. The jack-shaft and sliding gear shaft are equipped with ball bearings with provisions made for their proper oiling. The air compressor is geared to run at 400 r. p. m. at 35 miles per hour. Upon the floor of the fish tank are spaced three especially constructed air distributing pipes. These pipes run the entire length of the tank and are connected with the copper coil in the cooling tank by means of a rubber hose. A rubber hose runs from the air compressor to an oil trap mounted upon the cooling tank (this trap to remove from the air any oil discharged by the compressor) and from the oil trap to the copper coil in the cooling tank. A small copper tube connecting the air line and the pressure gauge which is mounted upon the instrument board, together with an air check valve installed in the air line between the copper coil and the air distributing pipes, completes the equipment.

The outfit operates as follows: The fish tank is filled with water to a depth of 17 inches which amounts to approximately 20 cubic feet of water. The water is cooled to the desired temperature by the addition of ice. The cooling tank is filled with ice. The fish to be transported are then

placed in the main tank, and the automobile motor started. The power take-off is then shifted into gear which starts the compressor. The compressor delivers the air through the rubber hose to the oil trap, thence to the copper cooling coil and thence to the air distributing pipes located in the main fish tank, and as a result bubbles arise in the water of the fish tank not unlike the bubbles arising in a glass of champagne. The adjustable air check valve in the air line answers two purposes, viz: It builds up a pressure of approximately 25 lbs. which is indicated upon the pressure gauge mounted upon the instrument board, thereby assuring the driver that the fish are getting air, and it aids in the radiation of heat in the copper coil. The action of the cooling coils keeps the water in the tank at the original temperature almost indefinitely. A heavy canvas tarpaulin is stretched completely over the tank to prevent the water from splashing out and for the further purpose of preventing the sun's rays from heating the water.

At destination, the fish are removed from the tank by means of a small dip net and carried to the waters to be stocked. As much time as is necessary may be consumed in the planting and proper distribution of the fish.

These Buick chassis above mentioned are constructed to carry a seven passenger sedan body weighing 1,000 lbs. The weight of the entire equipment, together with the driver, seat and top, is less than 500 lbs., and the weight of the water in the tank is approximately 1,200 lbs., therefore, the entire load upon the chassis is equivalent to placing a 700 lb., load and driver in the seven passenger sedan body for which the chassis was constructed. From these figures it can be readily seen that these cars are by no means overloaded.

The attached table will indicate the amount of fish carried on an average trip, as well as the adaptability of the equipment under all conditions. The plantings embraced in the enclosed table were made from elevations of 4,500 to 11,000 feet, over all kind of mountain roads.

The reason for the low average of quarts of fish carried on each trip is due to the fact that the best distribution could not be had by carrying capacity loads. It will be further noted that on trips where fry were carried, the quantity is materially reduced. This is necessary as fry do not carry as successfully as fingerlings. Also, it has been determined that fifteen per cent more Rainbow than Eastern Brook can be carried safely.

All fish to be transported should be starved approximately thirty-six hours. If this is done and only pure water re-

duced to a low temperature used, a load of seventy-five quarts of fish may be carried under all conditions.

Fish should be loaded into tanks direct from rearing ponds, great care being used to avoid water from pond being placed in the truck with fish. This is accomplished by dumping fish from seine into dry tub, then quickly into the tank.

Date 1926	Mileage	From	To	Quantity (qts)	Oil	Gas	Repairs
April							
23	103	Springville	Provo River	50	3	8	
24	105	Springville	Provo River	60	2	9	
25	100	Springville	Provo River	65	1	7	
26	118	Springville	Strawberry	70	1	8	
27	256	Murray	Logan	35Fry	6	13	
28	116	Murray	Midway	35	1	15	
29	126	Springville	Strawberry	70	1	10	
30	137	Springville	Strawberry	70	1	10	
May							
1	127	Springville	Strawberry	65	7	10	
2	116	Springville	Strawberry	65	1	9	
3	127	Springville	Strawberry	65	1	10	
4	126	Springville	Strawberry	65	8	9	
5	209	Springville	Lower Provo	50			
		Murray	Mantua	35Fry		15	
6	247	Murray	Logan	50	1	17	
7	15	Murray		None			
8	80	Springville	Hobble Creek	75		6	.50
10	70	Springville	Am. Fk. Canyon	75	6	5	
11	144	Springville	No. Fk. Provo	65	1	16	
12	100	Springville		None			5.00
13	12	Springville					
14	151	Springville	Provo	65		12	
15	155	Springville	Provo	65	6	12	
17	165	Springville	Provo	65		13	
18	10	Springville		None		7	
19	24	Springville		None		2	
21	136	Springville		None	1	10	
22	128	Glenwood	Wayne County	65	1	14	
23	105	Glenwood	Salt Gulch	40	1	12	
24	86	Glenwood	Fish Lake	70		7	
26	181	Glenwood		None	7	14	
27	133	Panguitch	Panguitch Lake	65	1	16	
28	146	" (2 trips)	Panguitch Lake	140	1	17	
29	92	Panguitch	Glenwood	None		13	
	75	Glenwood	Fish Lake	65			
30	195	Richfield	Fish Lake	60		16	
		Richfield	Springville	None			
June							
1	125	Springville	Salt Lake	None		9	
2	153	Springville	Beaver Creek	25,000 fingerlings	6	12	
3	190	Springville	Strawberry	45		13	
		Springville	Willow Creek	35			
4	129	Springville	Strawberry	45		10	
5	194	Strawberry	Duschesne, Strawberry River Springville	None		15	
6	112	Springville	Strawberry	50	1	10	
7	133	Springville	Strawberry	50		10	
8	65	Springville	Strawberry	50		5	
9	78	Strawberry	Springville	None		5	
10	62	Springville	Strawberry	55	6	5	
11	10	Vicinity	Strawberry Valley	None		1	
12	74	Strawberry	Provo	None		6	
13	133	Springville	Strawberry	55		11	
14	122	Springville	Strawberry	50		10	
15	174	Provo to	Glenwood to Fish Lake	50		13	3.25

Date 1926	Mileage	From	To	Quantity (qts)	Oil	Gas	Repairs
June,	Continued						
16	81	Fish Lake to Glenwood	Richfield to Fish Lake	55		9	
17	153	Glenwood	(2 trips) to Fish Lake	130		14	
18	158	Glenwood	(2 trips) to Fish Lake	145		16	14.19
19	241	Glenwood	Fish Lake	75		20	
		Glenwood	Provo	None			
20	50	Salt Lake		None		4	
22	45	Salt Lake	Provo	None		3	
23	189	Provo	Springville to				
		Lake Trial to	Springville	40		11	
24	146	Springville	Strawberry	40		10	
25	225	Provo	Springville to Salt Lake				
		Murray	Logan Hatchery to				
		Bear Lake	Logan Hatchery	50			
26	68	Logan Hatchery	Bear Lake	35		18	
	31	Logan Hatchery	Logan River	29			
27	65	Logan Hatchery	Logan River	72			
28	8	Logan Hatchery	Logan River	28			
29	92	Logan Hatchery	Salt Lake	None			
30	100	Murray	Wanship and Rockport	65		13	
July							
1	43	Murray	Brighton	60		10	
2	55	Murray	East Canyon	60	1	13	
3	18	Murray	Spring Runs	22			
6	43	Murray	Springville	None			
7	57	Springville	Lake Trial	50	3	7	
8	100	Springville	Lake Trial to				
		Rockport	Provo	40		14	
9	98	Springville	Lark's Ranch	50		7	
10	133	Springville	Murdock Power				
		Plant to Murray	to Salt Lake	55	7	8	
11		Salt Lake	Springville	None			
12	124	Springville	Provo Lakes	40		12	
13	129	Midway	Provo Lakes	40			
			Springville			10	
14	132	Springville	Provo Lakes	40			
			Midway			10	
15	128	Midway	Lost Lake	50			
			Springville		3	14	
16	115	Springville	Killcare	40		9	
17	116	Springville	Killcare	40	2	10	
18	104	Springville	Woodland	40	2	9	
19	103	Springville	Woodland	45		9	
20	168	Springville	Duchesne River	40			
			Roosevelt			8	
21	137	Whiterocks	Trout Creek	20		10	
22						16	3.25
23	182	Whiterocks	Salt Lake	None			
29	248	Salt Lake	Murray Hatchery				
			Evanston, Wyo.	100,000 Fry		17	
30	55	Murray	Farmington	None		19	
Aug.							
4	155	Murray	Springville				
			Knight's Ranch	50		6	
5	158	Springville	Killcare	50			
			Stewart's Ranch				
			Springville		7	8	
6	55	Springville	Salt Lake	None			
7							14.10
9	110	Salt Lake	Springville				
			Cottonwood	50		14	
10	127	Springville	Cottonwood				
			Ranger Station	50		13	6.00
11	143	Springville	Diamond Fork	40	2	11	
12	76	Springville	Weber River	45		6	
13	139	Springville	Weber River	52		10	
14	156	Springville	Weber River	50		10	
15	156	Springville	Beaver Creek	50			2.50
16	113	Springville	Payson Canyon	40		8	
17	271	Springville	Scofield	30		6	6.75

Date 1926	Mileage	From	To	Quantity (qts)	Oil	Gas	Repairs
August, Continued							
18	197	Springville	Chalk Creek	40		6	
19	144	Springville	Fish Creek	50		14	
20	143	Springville	Scofield	50		10	
23	170	Springville	Midway Provo Lakes	40	6	12	
25	121	Springville	Springville Midway				
26	118	Midway	Provo Lakes	40		16	1.25
27	120	Midway	Coalville	45		10	.50
			Provo Lakes	40			
28	155	Springville	Springville Midway			5	
			Head of Provo	40			
			Springville			11	
Sept.							
2	112	Springville	Strawberry	50		15	
3	131	Springville	Cottonwood and Gooseberry	50	7	8	
4	162	Springville	Huntington	50		14	3.50
5	196	Springville	Lake Canyon Cleaveland	50	2	13	1.25
6	145	Springville	Sanpitch	50	2	12	
8	75	" (2 trips)	Provo River	50			4.50

Cost of Equipment and Operation

Original cost fish planting truck chassis		$1,631.72
Cost of fish planting equipment		440.89
Total mileage—April 23 to September 8	13,557	
Mileage—fish planting exclusively	11,386	
Total number of quarts of fish planted (April 23 to September 8)	5,008	
Cost of oil to date		40.60
(Estimated cost of oil) (50,000 miles)		160.00
Cost of gasoline to date		261.25
(Estimated cost of gasoline) (50,000 miles)		875.00
Additional repairs to date		66.54
(Estimated cost of repairs) (50,000 miles)		500.00
Cost of three sets of tires (50,000 miles)		600.00
Total cost of operation		$4,575.90

(Basing life of truck at (50,000 miles)
50,000 miles will plant 22,035 quarts of fish.
22,035 quarts of fish at cost of $4,575.90 makes a total planting cost of 20c. plus per quart.

*Note Average load carried—60 1/6 quarts (dry measure). Capacity load which can be safely carried 70 to 75 quarts (dry measure). By carrying capacity loads costs would be reduced accordingly.

Note. In considering the fish planting table: Trips marked "none" mean that no fish were carried, but the truck was in transit, empty, from one hatchery to another or for some other reason was not carrying fish. The number of fish per quart is not set out because, for the purpose of this paper, it was not deemed necessary. Some of the trips fish only averaging forty to the quart were carried, while on others the number ran as high as one hundred eighty, and in a few instances as many as two hundred and fifty to the quart.

THE STRIPED BASS (ROCK FISH) OF THE ATLANTIC COAST

By E. Lee LeCompte.

State Game Warden, Baltimore, Md.

The striped bass, or "rock", as it is commonly called, is a native of the Atlantic Coast, and is highly prized not only by commercial fishermen, but by the anglers as well. The striped bass is, in reality, not a true bass, although possibly related to the bass family. Most ichthyologists consider it a type between the perch and the sea bass, and throughout the entire territory which it inhabits along the Atlantic Coast, it is known as "rock fish".

The original habitat of the striped bass included the Atlantic Coast from the Gulf of St. Lawrence to the Gulf of Mexico. At present it seems to abound only between Cape Cod and North Carolina. Throughout this territory it ascends all suitable rivers to spawn and in the pursuit of food.

In the 90's the striped bass was very abundant in the Chesapeake Bay and Delaware Bay region. Due to inadequate protection, these fish are not now so plentiful as in former years, although large schools of them make their appearance each year.

In 1879 the striped bass was first introduced into the waters of the Pacific Coast by the shipment of 132 fish from 1½ to 3 inches in size and 30 medium sized brood specimens, 25 of which died during transportation. However, 135 reached California in good condition and were planted in Carquinez Straits at Martinez, and from this planting, the striped bass established itself in the Pacific Coast waters. To-day it affords excellent food and sport to fishermen from the States bordering the Pacific Coast waters. In 1882 the second planting of 300 fish was made in Pacific waters, being shipped from Shrewsbury River, New Jersey, to California. These plantings showed a wonderful increase from year to year, and to assure their success in the future, the California Fish and Game Commission in 1907 began an investigation as to the advisability of establishing hatchery sites for propagation of the striped bass. A small hatchery was started at Bouldin Island, and proved a great success.

SPAWNING.

The striped bass spawns on the Atlantic Coast from New Jersey to North Carolina between April and July. An observer of the U. S. Bureau of Fisheries in describing the breeding habits of the fish, states that when a female is in spawning condition, the males gather about her in great numbers. A single female, which might weigh from 5 to 50 pounds, would have around her 20 to 50 small male fish, all of which would weigh less than 2 pounds each, and they seemed to be the only males present. The water was discolored with blood from the fish finning one another while contending for the female. The eggs are about one-twentieth of an inch in diameter, produced in large numbers and usually very fertile. It has been stated that two females produced 1,000,000 eggs each. A 20 pound female, caught on the Atlantic Coast, is claimed to have produced 1,500,000 eggs, estimated on the basis of 25,000 to a quart.

GROWTH.

The striped bass grows very rapidly. Young fish an inch long in the Chesapeake Bay the second week of June were observed in October to have grown to a length of 4½ inches. The young fish 5 to 9 inches in length, which are so very plentiful in the Atlantic Coast waters during February and March are the hatch of the previous year. The U. S. Bureau of Fisheries claims that in a Rhode Island pond, striped bass weighing a half to one pound in June increased in weight to six pounds the following October.

HABITS.

The striped bass does not cover great distances, or spend much of its life in the ocean. In Chesapeake Bay in Maryland it is our main food fish during twelve months of the year. When following streams in pursuit of spawning grounds, it is caught not only in salt or brackish water but also taken in fresh water at the heads of rivers. It is believed that in the late fall and winter the young fish, which have hatched out during the spring and summer, and which have reached a length of from 3 to 5 inches, abandon the shoal waters and seek the deeper water of the channels, and thence pass out into the ocean, where they start up

and down the Coast. The largest catches in Maryland waters are during the summer and early fall. After the cold weather sets in, the fish pass on to deeper water where they remain during the winter months.

FOOD.

The principal food of the striped bass appears to be small fishes. On opening the stomachs of these fish, I have observed on numerous occasions the alewife and other small species. They also feed on small crabs, shrimp, seaworms, etc., found in the Atlantic Coast waters. The main diet of the young bass is minnows, shrimp, etc. An investigation disclosed the fact that marine worms composed 50 per cent of the food, crustaceans and other marine species 48 per cent, and small fish only 2 per cent. Young shrimp and fish were taken from the stomachs of young bass from 3 to 4 inches in length, and other small crustaceans from the stomachs of specimens 3 inches and under in length, showing that the young bass begin feeding on small species of crustaceans and worms, and as they grow in size consume shrimp and young fish.

COMMERCIAL VALUE.

It would be almost impossible to estimate the commercial value of the striped bass to the fishermen of the Atlantic Coast. A census taken in 1908 places the value at $314,000, Maryland leading with a value of $65,000. The same census gives California a value of $135,000. With these facts before one, it can readily be seen that the Atlantic Coast States will have to give better protection to the striped bass and thereby increase the supply, otherwise, the Pacific Coast will outstrip us, as they have done in the case of the white shad, which was transplanted from the Atlantic to the Pacific waters.

PROTECTIVE LEGISLATION.

The laws which are found on the statute books of the Atlantic Coast States are probably responsible for the striped bass being as plentiful as it is to-day, but the supply could be vastly increased by suitable protective measures. Speaking for Maryland, our laws are entirely inadequate. The spawning season being from April to July, it

can be seen that the Maryland law, which provides that no striped bass weighing over 20 pounds may be taken during May and June, does not take care of the situation. No "rock" weighing over 15 pounds should be taken at any time of the year, as this size fish is the one producing the spawn. Our law further provides that no person shall take any striped bass under ten inches. The minimum size should certainly be increased to 18 inches.

The majority of striped bass are taken on the Atlantic Coast by means of nets, which should be regulated by law, and during the spawning season, the fishermen should be compelled to raise their nets at least one-fourth of the period, thereby permitting the fish to reach their spawning grounds unmolested. The law should also provide that no net be fished during the spawning season with a mesh less than 5 inches. This regulation would also help the shad. The minimum and maximum sizes suggested should apply to the angler as well as to the commercial fisherman.

During the summer season of 1926, Maryland anglers have had excellent sport with striped bass, and fish ranging from 1 to 11 pounds have been taken by rod, hook and line. Most of the fish, however, have been caught on what is known as the Huntington drone, by trolling. The angler either by the use of a hand line or a salt water reel allows the drone to trail at a distance, and the deeper the water the more weight is used as a sinker. The Huntington drone is in the shape of a shoe-horn, with a hook soldered to same. It is used without bait and is said to be very effective.

BREAM OR BLUEGILLS FOR STOCKING SMALL LAKES

By Dell Brown.

Superintendent Fisheries Station, Mammoth Spring, Arkansas.

It is not the intention of this article to attack the popularity of the black bass, it being one of the gamest of American fishes in large lakes or streams. Where conditions are suitable black bass should at all times have preference. There are but few sportsmen or fishermen who would not prefer black bass in their streams or lakes to any other fish, but since all waters are not suitable for that species, to plant them in small lakes which are not suitable for their growth and reproduction only means a waste of funds and efforts to the fish culturist, also a disappointment to the applicant, who has visions of great sport in a few years fishing in his protected pond, to find but few fish. Had he stocked his waters with bream—fish that are more suitable for small lakes—he would have been agreeably surprised by finding large numbers of fine fish. While the bream does not attain as large size as the black bass it is equally as game.

Quoting from Jordan & Evermann, "Bream is perhaps the best known and certainly the most important of all our true sunfish. It is one of our most variable and widely distributed species, and though found in quiet streams it is above all, the sunfish of the lakes. The bream is the largest of the sunfishes. Its flesh is firm and flaky, and has a delicious flavor, and among all the sunfishes it holds the highest rank as a game fish. It can be taken at any time in the year, even through the ice in winter. It will take any sort of bait and can be taken with any sort of tackle, either by still fishing or trolling. They do not seize the hook with a rush, but quietly suck it in and the fight does not start until the fish finds that it is caught. From then the fight starts and is of the most vicious kind, and is kept up to the end with a persistency and viciousness that makes the bream "the gamest of all fishes for its size."

For several years many of the Federal and State hatcheries have propagated and distributed bream, still I do not believe fish culturists generally have given the bream the attention they deserve. Not only could they be raised in greater numbers, but they could be shipped to applicants having small lakes instead of black bass. While the ap-

plicant who is not familiar with the bream might not be so well pleased at first, after about two years the results would be so satisfactory in the nice fish he can catch that he would never try to stock a small lake with black bass.

It is realized that the majority of sportsmen, when thinking of fishing turn their thoughts to bass, trout, or some of the larger game fish. So many of our large lakes have been drained, and streams polluted and ruined for game fish life by drainage ditches, that the larger game fishes will only thrive in real wild water where they have ideal conditions, such as temperature, spawning and predatory habits. So why shouldn't more attention be given to the bream which will do well in small privately-owned and protected ponds that can not be polluted by the public? While we should continue to propagate bass and trout in streams and large lakes of 5 acres or more, why not encourage the planting of bream in smaller inclosures. The main advantage of bream over bass in small lakes is that unlike the bass they are not cannibalistic. Bream will reproduce at one year of age. Their spawning period is much longer than that of the bass, and should weather conditions destroy the spawn during one month, the later spawn will hatch. At Mammoth Spring, Arkansas, bream spawn in April, May, June, July and August, and during this period one is sure to get some hatch. Bream consume a larger amount of food than bass.

We will now take up bream from the fish culturist's point of view. The brood stock can be raised in the hatchery ponds, thus preventing a shortage of brood stock, as is often the case with black bass. Where bass can be had they usually cost $1.00 per head, with great loss during the first month from handling. Bass seldom become as domesticated as bream in the hatchery ponds. Under similar conditions it is believed that five times the number of bream 2 inches in length can be produced as can bass.

So much for the fish culturist. How about the applicant who receives the fish? You all know we have many applications for fish for small ponds and lakes, and it is my opinion that bream should always be substituted for bass in lakes of five acres or less, which would insure better success in pounds of fish than bass. Take a three-acre lake, stock it with 2,000 No. 1 black bass in June, and by September the fish will be about 3 inches in length, say about 500 of them, as the other 1,500 will be gone, they

having been made food for the remaining 500. By the following June there would probably be 200 bass averaging 7 inches in length, the missing 300 having made food for the remaining 200. By the following May these fish will be about 2 years old, 200 of them if they all live, and should weigh about one and one-half pounds each, a total of 300 pounds. Those hatched May 1 will be about the right size to feed on the hatch of June 1, and those that ate the June 1 hatch will be three to four inches long the following fall when the breeders are putting on flesh for the winter and are very voracious and the majority if not all the fingerling fish will be devoured by the brood stock. This will be the case each year. The owner of the bass pond will wonder why his fish do not increase, and during that time will likely make application for more bass, and if he gets them will put them in the lake to furnish more food for his bass. This is not theory; just try a small lake with bass; it may not do so well.

Take a three-acre lake and stock it with 2,000 one-inch bream during the month of June, and the following May you will have under ordinary conditions 1,800 four-inch fish. These fish will be spawning and will continue to spawn until September. The following June you will have about 1,500 one-half pound bream, total weight 750 pounds, with many thousands of yearling fish; both the two-year old and one-year old fish will be spawning. There will be all the fish in your lake that it can support without applying for more and you can start fishing as there will be plenty of breeders and young fish. If you could catch the entire 1,500 one-half pound bream from your lake there would be plenty of them coming on.

For those considering the bream proposition in small ponds it would be well worth undertaking. Fish culturists who raise the fish and distribute them should make every effort to furnish those most suitable for the waters to be stocked. In this way our efforts will show results, the fish supply will increase, the applicant will be pleased, and our fish hatcheries will be more popular as a real necessity.

Fish culturists raising and distributing fish should determine what fishes will live and thrive in the waters to be stocked in their respective territories and furnish that species. It is not always possible to supply the species of fish requested, as it often happens that the applicant does not know what variety he wants or what species will do well in the waters he desires to stock.

THE SHAD—PRIDE FISH OF THE EAST COAST

By Swepson Earle.

Conservation Commissioner of Maryland.

This United States of ours is rapidly increasing in population, and naturally there is a greater demand for all foodstuffs. The demand for seafoods has increased enormously since the World War, when we were urged to eat them in order that meats and less perishable foods might be shipped to the fighting men abroad. This slogan did not stop with the termination of hostilities, people having found that seafoods were palatable as well as nutritious, have continued to use them not only once but several times weekly, which has caused a greater drain on the waters of the country.

The shad is one of the most palatable and popular of fishes. Its natural range on the Atlantic Coast of North America is from Florida to Newfoundland, its center of abundance being from North Carolina to Long Island, and New York. Within this zone comes the Chesapeake Bay, the great inland sea, which seems always to have been the true habitat of the shad, as well as other fishes of national importance.

Every coast state must realize by this time that the shad is decreasing at an enormous rate, and only by the coordinated efforts of the several States in regulation of nets and by artificial propagation, can we hope to stem this depletion. "We do not have to go back many years to find that the shad production of the Atlantic seaboard was approximately 26,000,000 pounds. Within two decades, this production has decreased almost eighty per cent, while the value has advanced nearly five hundred per cent."

The Chesapeake Bay, with its one hundred and forty-eight tributaries and branches, is one of the greatest inland seas in the world. This body of water is controlled by the States of Virginia and Maryland. The entrance gates of the Bay are in Virginia, and all fish seeking the spawning grounds in the upper part of the Bay must swim sixty-five miles before crossing into Maryland waters. Of the many tributaries of the Chesapeake, the Potomac is the most outstanding one, and in the days of George Washington and John Marshall, planked shad was regarded as one of

the most delicious dishes for the table, and has gone down from generation to generation to be enjoyed by the people of these two States. During the spring run of shad, excursionists leave Washington for Marshall Hall, Colonial Beach and other resorts along the Potomac, in order that they may partake of these dinners, and the reputation of planked shad has gone from the National Capitol to every section of the country.

The most striking figures to show the decline of the shad, are given by the U. S. Bureau of Fisheries in their statistics for Potomac River. In 1901, 2,979,233 pounds of shad valued at $119,366.00 were taken. Since that year, the decrease in the supply has been gradual but continuous. In 1925, the Potomac yielded 696,632 pounds of shad, valued at $163,398.00. While all commodities and foodstuffs have advanced materially in the last ten years, the great increase in the price is largely due to decrease in supply, and while shad sold as low as 4 cents in 1901, its value has advanced four hundred and ninety-two per cent in twenty-four years.

The United States Bureau of Fisheries maintains a shad hatchery at Bryant's Point on the Maryland side of the Potomac River, opposite Mount Vernon, and this hatchery is doing much in artificial propagation of shad. From the report of Mr. Glenn C. Leach of the Bureau we find the average take of eggs for the period from 1919 to 1923 is 34,756,400 per annum. The egg-take on the spawning area in proportion to the catch of fish in the entire River was 64,000,000 per 100,000 fish. He further states that at the present time under existing conditions on the Potomac River, a maximum egg-take is secured. Mr. Leach further recommends that it is most desirable that the shad be unmolested on the spawning area, and that the proper escapement be provided for, and that commercial fishermen strip the ripe shad caught in their nets, fertilize the eggs, and return them to the water to develop under natural conditions.

The Conservation Department maintains a shad hatchery on the Eastern Shore of Maryland that turned out last year 2,600,000 shad, 80,000 of which were held in boxes until they attained a size of two inches, and then liberated. It was found that shad could be held with very little expense to the State, and the mortality was greatly reduced when liberated. It is the expectation of the Department in 1927

to turn out 5,000,000 shad. However, this depends largely upon the supply of shad reaching the upper waters of Chesapeake Bay. While Maryland and Virginia use the Potomac concurrently for fishing, the shad must run the gauntlet of over six thousand nets after passing inside the Capes in order to reach the waters of Maryland. It has been urged upon our sister State that regulatory measures be placed on the nets, in order that the shad may have a chance in this bay. The State of Maryland has agreed to set aside spawning areas where the shad will be protected.

I could not help being impressed by the statement made by a representative from Vermont at a game conference some time ago, when he said, "We are a small State and have but little in natural resources, but what we have, we are going to make a damned good effort to hold." The Central Atlantic States have been blessed with an abundance of natural resources, but fishermen permitted to take and destroy fisheries in a wholesale way have placed us in the precarious position in which we find ourselves to-day.

The Bureau of Fisheries comes in for praise for its work in transporting shad as early as 1871 from the Hudson River to the Sacramento River, California. This was followed by other deposits in 1873 and 1880. From these small plantings, shad have multiplied and distributed themselves along three thousand miles of coast, from Southern California to northeastern Alaska, and just a year ago, California shipped, in refrigerator cars, to the Atlantic Coast approximately 2,000,000 pounds of shad which were solemnly sold as the great and rare delicacy of the Atlantic waters.

While the shad supply has reached an alarming state of depletion, it seems that we still have time to save this national fish if we work in a consistent and unselfish way. Referring to the meeting held in Washington by Honorable Herbert Hoover, Secretary of Commerce, to consider ways and means to save the migratory fishes of this country, it was agreed that only through co-ordination of the several States can we expect to maintain the shad, lobster and sturgeon.

SOME FRESH-WATER FISHES OF SIAM

By Hugh M. Smith.

Commissioner of Fisheries in His Siamese Majesty's Government.

Some time ago an itinerant journalist who in the course of his travels had reached Bangkok was advised to interview a Siamese friend of mine as a person who could give him authentic information about the animals, plants, industries, customs, etc., of Siam. The journalist visited the attractive home of his prospective informant located on the bank of the mighty Menam Chao Phya a few miles above Bangkok, and soon threw out a verbal drag net by asking what things there were in Siam that would be of interest to occidental readers. "Well," replied my friend, "let us first take the fishes: we have among others walking fishes and climbing fishes, wrestling fishes and fighting fishes, singing fishes and shooting fishes." The reported skepticism of the journalist may be readily understood but, as a matter of fact, Siam has all the remarkable fishes named and many more besides.

Fish play a very important role in the economic life of the Siamese people. Fish are eaten in every Siamese household daily. The taking of fish ranks next to the growing of rice among the basic industries and gives employment to more persons than any other industry except agriculture. The future welfare and development of the country depend in no small degree on the continued availability of an abundance of fish, especially in the fresh waters.

To the student of fishes, Siam is a veritable paradise. Here are found in profusion a host of fishes, celebrated in the literature of the west, that most western fish specialists never have an opportunity of knowing except from books or from preserved specimens in museums. The fishes that have helped to make Siam famous and render it a most inviting field for the biologist constitute an ichthyological galaxy such as few other countries can surpass.

The fishes of Siam have received less attention from the zoologist than any other class of back-boned animals. Large sections of the country remain unexplored so far as their fish life is concerned. From more than half the land area, not a single species has been collected, identified, or recorded in scientific literature. It goes without saying that interesting forms new to science are constantly being met with.

AESTIVATING FISHES.

In cold climates where the waters of ponds, lakes, and streams may be ice-bound for many months each year, some of the fishes go into a state of diminished activity or suspended animation, lying motionless on the bottom or buried in the bottom mud. This corresponds with the period of hibernation which bears and other warm-blooded animals of northern regions undergo.

Now, in countries like Siam, India, and Australia, in which there is a protracted period of drouth, with more or less complete drying up of streams, ponds, and swamps, the fishes have to adapt themselves to the absence of water and some of them are able to survive for months without food or water, undergoing a state of existence which may be called aestivation. Aestivation is made possible by the possession of accessory breathing apparatus, by means of which fishes may make direct use of atmospheric air, in addition to taking air from the water.

Here in Siam there are three different types of fishes, inhabiting chiefly ponds and swamps, that are able to withstand the prolonged absence of water. They are the well known climbing-perch *(Anabas)*, the cat-fishes of the genus *(Clarias)* and the murrels or serpent-heads *(Ophiocephalus)*. By virtue of their peculiar respiratory apparatus, they are always exposed for sale alive in the markets, and supplies that remain unsold one day are brought back alive the next day and the next.

When the ponds or swamps in which they are living begin to go dry, these fishes often move overland to other waters, and may be met with even on dusty roads. If they remain they penetrate deeper and deeper into the mud as desiccation goes on, and they may reach a depth of a meter. In a stiff-walled chamber of damp mud, entirely without water, breathing atmospheric air through the porous soil or through cracks in the parched earth, expending no energy and requiring no food, they remain for an indefinite period, in some cases certainly as long as 4 months, until the rains come and they are able to tunnel to the surface through the softening soil. It thus happens that a piece of land that has been bone-dry for months and is entirely cut off from communication with a river or canal, will be found to contain fish a short time after it is flooded by rain. It is no wonder that in parts of India the serpent-heads are believed to fall with the heavy rains and that in other parts of the east, including Siam,

this phenomenon should make a deep impression on foreigners.

I have no doubt that there are many underground tragedies, as the drying of the mud proceeds faster or further than the fishes are able to go. These fishes can survive only if their skin and their delicate respiratory epithelium remain moist.

I am personally familiar with curious fishing methods and procedures in many parts of the world, but I have never seen anything that struck me as more extraordinary than a dry-land fishery I met with several years ago in Peninsular Siam. In a large area that is first lake, then swamp, and finally dry land, the fishermen operate systematically on the top-soil, removing it layer by layer in blocks by means of spades and knives until they reach the moist stratum in which the serpent-head pla chon has taken refuge. Sometimes, at a depth of half to two-thirds of a meter, pockets of fish are discovered and good hauls are made; at other times much excavating may yield very scant returns.

THE CARP FAMILY.

In Siam, as in India, America, and various other parts of the world, the carp family occupies a very important place. They are much more numerous as to individuals, genera, and species, than are any other family, and they are correspondingly prominent in the fisheries, in the markets, and in the diet of the Siamese. They abound in all the rivers and canals and lakes; and some strictly fresh-water species have a periodical up-stream migration when they crowd the streams in incredible numbers and are caught by practically every able-bodied person living on or near the banks, huge dip nets, wicker traps, and every other suitable contrivance being operated in unbroken lines in close set formation along hundreds of miles of rivers during the comparatively short season of the annual run.

Most of the members of this family have no English names and there are no exact equivalents of the genera in America or Europe, so that they can be referred to only under their scientific names. It may be noted that many of the species are of great beauty in both form and color; a common color feature is bright red dorsal, caudal, and anal fins, with the caudal often marked by a narrow black stripe along the margin of each lobe. The genus with most members is *Puntius*, followed by *Dangila*, *Osteocheilus*, and *Cyclocheilichthys*.

Other genera with common, widely-distributed species are *Hampala, Cirrhina, Luciosoma, Barbichthys, Leptobarbus, Balanteochilus, Morulius, Rasbora, Chela, Culter Macrochirichthys,* etc. The largest of the tribe is *Catla,* which in the river at Bangkok attains a length of two meters and is caught by anglers using a light rod.

Among various kinds of cobitids or loaches, the strikingly beautiful members of the genus *Botia* are exceedingly abundant in places.

THE CAT-FISHES.

The cat-fishes in Siam constitute a very conspicuous element of the fauna as regards both number of individuals and number of species. They figure prominently in the commercial fisheries and in the market supplies, and they have a wide range in size, habits, and food value. The Siamese cat-fishes fall into seven families, and may be found to comprise nearly one hundred species, a few of them exclusively marine. Almost every time I go into the field I come upon kinds of cat-fishes not previously met with, and a number of hitherto undescribed genera and species have been found.

Both pygmies and giants are to be met with among the Siamese cat-fishes. Thus, in the hill streams there is a species *(Amblyceps)* only 7.5 c. m. long, while in the Meklong, the mighty river that marks a part of the eastern boundary of Siam, there occurs a species of *Pangasius* which is probably the largest of all cat-fishes, attaining a length of 3 meters and a weight of 300 kilograms. A common form in the large rivers of central and northern Siam is *Wallago,* which reaches a length of more than a meter and has the shape and habits of a muscallunge.

Among large coastal forms that ascend the rivers are about half a dozen species of the genera *Arius* and *Osteogeniosus* that practice oral incubation, that is, they are mouth-breeders. The ventral fins in the female are modified in a peculiar way for the obvious purpose of holding or guiding the eggs at the time of extrusion, possibly retaining them while being fertilized and enabling the male to take them into his mouth. The entire duty of hatching the eggs and caring for the young until the absorption of the yolk-sac devolves on the male, whose pharynx becomes dilated, gullet closes, and all feeding ceases for a period of probably six to eight weeks while he goes about looking as though he had the mumps, with his mouth crammed with 20 to 30 eggs, each 1.0 to 1.5 c. m. in diameter.

It is my opinion that the male cat-fishes thus lead a perfectly miserable existence, and by the time the last young have emerged from their mouth and feeding is resumed they have become exceedingly emaciated. In the net fishing in the rivers during the hatching period, when large numbers of the males are often caught, the eggs are gathered from the bottom of boats where they have been spewed out, or the eggs may be extracted from the fishes' mouths, and are separately exposed for sale in the markets.

THE FIGHTING-FISH.

The Siamese have from early times cultivated the little fighting-fish *(Betta)*, and in former years used to wager large sums on the outcome of combats between selected fishes, this sport taking the place of cock-fighting in other parts of the tropics. The cultivation of the fighting-fish and the laying of wagers on the fights still go on, but the sums now involved are comparatively small and the government discourages and disapproves this and other forms of gambling. There are now in Bangkok ten licensed public places where fighting-fish may be matched and bets laid on the outcome. The least amount wagered on a single fight in a licensed place is 10 ticals and the maximum is 100 ticals (1 tical = 44 cents). In one licensed place there may be ten fights in a day, and the owners of the fish have to pay the licensee ten per cent of the amounts wagered. The cost of a license for conducting a place for fighting-fish combats is one tical a day per table or ring, each place having about three rings. Under the terms of the license, the time for conducting fighting-fish contests is 6 a. m. to 6 p. m.

The Siamese fighting fish were for years called *Betta pugnax*. Unfortunately, that species has never been found in Siam and appears to be restricted to the Island of Penang. The Siamese form is *Betta splendens;* and about a dozen other species are now known from the Malay Peninsula, the Dutch East Indies, and Borneo, thanks to the revision of this genus by Regan.* In addition to the wild form, that is widely distributed in Siam, and the cultivated race which has been derived from the wild species, there may now be met with in Siam a number of highly ornamental varieties of fighting-fish whose exact history and origin I have not been able to determine, but it may be confidently asserted

*Proceedings of the Zoological Society of London, 1909, P. 767.

that they did not originate in Siam. Each of the exotic varieties is characterized by a marked development of the fins, and by a dominant body color which is entirely different from that of any of the known species of wild fish.

These varieties may be well known to American fish fanciers but were entirely new to me. One form, called by the Siamese pla kat deng, or red fighting-fish, is said to have been brought from China about 20 years ago; the general body color in repose is reddish-brown, with darker edges to the scales; the very large and veil-like dorsal, caudal, and anal fins and the elongated ventral fins are blood red, which color the body assumes in fighting. A second form, which I have kept in my house, is called pla kat keo, or blue fighting fish, and is said to have come from Cambodia more than 20 years ago; it has body and fins of a rich caerulean blue overlaid with iridescent silvery white, but the fins are not so large as in pla kat deng; during fighting, a blood red color over-runs and may almost conceal the blue of body and fins. A third variety, called pla kat yipun. or Japanese fighting-fish, has been bred in Bangkok for at least 10 years and may or may not have originated in Japan; its body is of a dull orange color with dark red edges to the scales, and the fins, variable as to size but on the whole well developed, are rich garnet red, which color suffuses the whole fish during excitement; the form is rather hardy and has bred freely in small glass jars in my office.

There has been much wholly unnecessary misinformation and nonsense published about the contests of the Siamese fighting-fish, and authentic accounts are rare. A conspicuously erroneous account, as follows, was given in a general article on Bangkok appearing in the issue of *Asia* for March, 1921; the spirited description is marred by the fact that it contains scarcely a single correct statement:

> "The fighting fish are about the size of gold-fish. You catch one and put it in a bottle. Your neighbor does likewise. You put your bottle close to your neighbor's. Your fish become enraged. So does your neighbor's fish. They both flash all colors of the rainbow.
>
> They swell up. You bet on your fish. Your friends back you. After a time one fish or the other, hurling itself against the glass in a vain effort to reach its adversary, becomes so angry that it literally bursts. If it is your neighbor's fish that bursts, you win. If it is yours, you lose."

Fighting-fish are kept in tall rectangular jars of special design, somewhat larger at the top than at the bottom, and with a short neck and a wide circular mouth. Two males

of similar size that are to be matched are brought together in their respective jars for the purpose of determining whether they are in fighting mood. If both give evidence of a pugnacious attitude, as shown by their efforts to get at one another, they are transferred to a bowl or larger jar, and the fight immediately begins. The exceedingly rapid onslaughts are succeeded by short periods of calm, during which the fish may be regarded as sparring for position or having a breathing spell. The first and often the only evidence that the sharp teeth of the combatants have been used is the mutilation of the fins, which may proceed to such a point that every fin is reduced to shreds and large pieces of the fin substance may be lost. Exceptionally blood is drawn. On two occasions when I was giving exhibitions to some friends, my fish grasped one another by the jaws and remained locked together for some minutes. It occasionally happens that fish are killed, but the match is usually decided by one fish refusing to continue the struggle while the other is ready and anxious to go on. Mutilated fins rapidly regenerate, and in a few weeks there may be no marks of a fierce combat.

Breeders and fanciers of fighting-fish strive for fish with great powers of endurance, and cultivation has done wonders in the development of this quality. Wild male fish, from open waters, will fight after a few days of captivity, but they seldom fight for more than 15 minutes, while the most highly cultivated fish will actively fight for 6 hours. The ornamental introduced varieties to which reference has been made may keep up the fight for 3 hours.

In Bangkok there are about 10 breeders of fighting-fish who make a business of supplying fish for sale, and there are said to be at least 1,000 other persons, amateurs, who breed fish for their own use.

THE WRESTLING-FISH.

Among several other kinds of fishes cultivated by Siamese amateurs and employed in individual tests of strength and endurance is a little native fresh-water hemirhamp *(Dermogenys)*. The fish is viviparous, the female is much larger than the male, and under domestication both sexes have undergone a noteworthy increase in size over the wild fish, which is found in ditches and drains throughout this part of Siam. In allusion to the long, slender lower jaw, the Siamese call it pla khem, or needle-fish.

The rearing of this little fish in captivity affords an inviting field for the fish culturist and biologist, and a special paper might be devoted to it, as the subject is rather extensive. A mere outline will here be given. The breeding of this fish for fighting purposes has now been going on in Siam for somewhat more than 50 years. There is no Siamese literature on the subject and there are only a few meager references in western publications.

The usual age at which the fish are allowed to breed is 9 to 11 months. Some fully matured females 11 months old were 8.6 c.m. long, males of the same brood were 5.4 to 5.6 c.m. long. The youngest age at which females may bear young is 3 months. As males begin to develop pugnacious qualities at 4 to 5 months, they would probably breed then if permitted to do so. The young are born about 40 days after a pair have been put in the same receptacle, and usually a second brood comes 20 days later without the female having had access to a male. The size of the broods depends on the size of the female. Sometimes nearly or quite 200 young are born at one time, sometimes 100, and sometimes only 60 to 70. The second brood, which represents the product of the other ovary, may be more numerous than the first. The extrusion of a batch of young may occupy several hours. The young are eagerly devoured by the female, in preference to natural food, while the male eats the young only when driven to it by extreme hunger.

The sexes can be distinguished by an expert when the fish are 30 to 40 days old. According to the local breeder of greatest experience and most scientific methods, if at that time the females are segregated and kept apart until 6 to 7 months old some of them will give birth to a few fish (4 to 6) without ever having access to males. These young are said to be always females and never fertile. This important claim for parthenogenesis needs confirmation.

A large, healthy female may breed five or six times in a year, but it usually happens that the average fish dies after having had her second or third brood. The males live about two years if they are not employed in fighting, which occupation seems to shorten their existence. Their only food is mosquito larvae, which are especially bred for the purpose. The young are given no special food, but begin to eat mosquito larvae at an early stage.

The combative instinct is strong in both sexes. It is only the males that are formally matched, but an active male that has been kept alone for some time may at first attack a female

if put into a bowl with one, as he sees not a female but simply a fish, and sometimes the female is the aggressor and, being so much larger, may kill the male. Females that exhibit a fighting tendency are sometimes disciplined by being seized by the upper jaw: in their struggles to escape they may break off a part of the jaw or pull out a small bone—this does not incapacitate them for breeding but puts a damper on their fighting proclivities. A male that has once been worsted in a combat is of no further use for that purpose and is not allowed to breed, but is kept apart with other unfortunates of the same kind and is used for training other fighters.

I have not found any printed references to the matching of these fish, and will therefore give a short account, based on personal observations of my own fish and of the extensive breeding establishment in Bangkok conducted by a former Siamese minister to Washington.

While fighting-fish are always kept in glass jars, wrestling-fish are always kept in earthenware or other opaque vessels, otherwise they will damage their needle-like beak in efforts to get through the glass. When being taken to and from matches, the males are carefully carried by hand in a polished coconut shell suspended by cords from a brass hook, the shell resting on a brass ring and having a tightly-fitting wooden cover with a perforation. Every effort is made by the owner to prevent the injuring of fins or beak. Sometimes 100 or more ticals are wagered on a single encounter.

The essential feature of the struggles between matched pla khem is wrestling rather than actual fighting, and I have therefore taken the liberty of bestowing on the fish the name of wrestling-fish, a designation which has been well-received and has now become current in Bangkok.

Selected males are placed in a bowl of water, and if they are of good stock and in good condition they immediately clinch—that is, they rush together and grasp one another at the base of the lower jaw. While thus tightly locked, the long axes of their bodies being at a right angle or acute angle to one another, their tails bend outward, the dorsal and anal fins expanded, the caudal and pectoral fins violently and constantly agitated, they slowly move around the surface of the bowl, the obvious purpose being to tire one another out or to inflict some injury on the seized parts. After some minutes they may break apart and make savage darts aimed at the head or anterior part of the body, and then, quicker than the human eye can follow, they will be again locked in a bill hold. Occasionally one fish may seize the other by

the tip of its lower jaw, which is considered a favorable position. Between the periods of active struggle, while still clinching, the fish may lie quietly for a few minutes with only their pectoral fins moving.

Among highly cultivated fish the struggle may last for several hours, while wild fish may fight for only a few minutes. The contest is decided when one fish shows a disinclination to continue the contest and runs away, or when one fish is killed or disabled. The most vulnerable part is the gills, and a lighting-like stab at the gill opening may draw blood and ultimately determine the outcome. Very exceptionally both fish are killed from injury or exhaustion. In the great majority of matches, however, the fight is not to a finish, and one fish or the other withdraws and refuses to come again to grips.

Two other fishes, belonging to widely-separated families, are used in fighting matches by the Siamese, but not to anything like the extent to which *Betta* and *Dermogenys* are employed, and neither is cultivated for the purpose. One of these is the attractive little anabantid *Ctenops*, the other is the still smaller cyprinodont *Panchax*.

THE HAIR-FINS.

The fighting-fish is the most diminutive member of a family which in Siam contains some large and highly-important food fishes, most of them characterized by the modification of the ventral rays into long, hair-like filaments and by the habit of making a bubble-raft in which the eggs are laid. Among these is the celebrated gouromi *(Osphromenus)*, known in Siam as pla ret, or rhinoceros fish, reaching a length of 60 c. m. and highly extolled as a species suitable for pond cultivation. The genus (*Trichogaster)* has three or four local representatives, all pond fishes and all most attractive in form or coloration, or both. The commonest and smallest species are called pla kadi. The largest and best, extensively used for stocking small ponds and well worthy of cultivation, is known as pla salid, which in a dried condition is a stable commodity for export.

THE SERPENT-HEADS.

The large and important family of serpent-headed fishes *(Ophicephalidae)* has 5 or 6 representatives in Siam. They are among the most valuable food fishes inhabiting swamps,

ponds, and sluggish waters generally. Several of them *(Ophiocephalus-striatus* and *Ophiocephalus-micropeltus)* attain a length of several feet, and may be regarded as staple food fishes for domestic use in the interior of the country. They are caught in immense numbers, and are consumed in both fresh and dried condition. Owing to their ability to live out of water for protracted periods, they are always exposed for sale alive. The commonest and best species *(O. striatus)* ranges from China to India. The breeding habits are interesting, resembling those of the American bowfin.

THE SHOOTING-FISH.

Under the name of pla sua, or tiger fish, the Siamese recognize a common river species with black bars or bands on a yellowish-brown background suggestive of the tiger. This is the celebrated *Toxotes jaculator,* variously referred to in zoological literature as archer-fish, blow-pipe fish, and shooting fish. The name archer-fish is inappropriate because it involves a bow as well as a bolt; the name blow-pipe fish perpetuates an entirely erroneous conception of the performance of the fish; the name shooting-fish seems to be the best available.

The general color of the fish blends well with the turbid water in which it is usually found, and as it swims at or near the surface in search of food, practically the only parts often visible to a human observer are the black marks on the back and a golden yellow ring around each eye suggestive of a spectacle frame. It readily takes insects and other food in the water, but its characteristic feeding habit is to propel a drop of water at insects on over-hanging vegetation, on piling, or on other objects above the water. When about to shoot, the fish approaches the surface at an angle of about 45°, with the tip of its mouth and its eyes just protruding. If there is an insect or spider in range, a globule of water corresponding in size with the size of the fish is ejected with great force and accuracy, and the unwary prey is dislodged, falls into the water and is quickly devoured. It is quite evident, from the deadly aim of the shooting-fish, that its eyes are adapted for distinct atmospheric vision. Usually only a single drop is dispatched at a given mark, but if necessary a series of water missiles may be ejected in rapid succession. On several occasions within my knowledge, the shooting-fish

has bowled small lizards from the side of a board over-hanging the water, and quite exceptionally and nearly always futilely the fish will shoot at moths, butterflies, and other insects flying above the surface.

The effective range of a full-grown fish (22 to 25 c. m. is about the maximum length attained) is any distance up to 1 meter, but the water pellets go much further and have often been observed to splash against the ceiling of an over-river veranda at least 4 meters above the water.

The shooting-fish responds quickly to attention from human beings, and congregates and remains at places where it is regularly fed. Scores of sceptical visitors to Bangkok have been shown the remarkable habit of the fish at the river-side place of my friend Dr. Yai S. Sanitwongse, who is usually able to keep a lot of performing fish on hand by feeding them bits of raw fish, chicken, or shrimp and by always rewarding them when they shoot at and hit a spider dangling by a fine thread from the end of a fishing pole. The fish that have been regularly fed day after day seem to resent neglect, and will apparently endeavor to attract attention by "shooting" at persons. On many occasions, Dr. Yai, while taking his breakfast on a veranda over the water, has had reminders of his wards in the form of drops of water splashing in his face, and at least twice in the past two years a lighted cigarette which he was holding between his fingers was extinguished by a well-directed shot.

The shooting-fish is almost intelligent enough to enjoy the liberties which some ichthyologists have taken with it. Thus, Dr. Francis Day, the leading authority on the fishes of India and Burma and the author of several monumental works on the subject, wrote:

> "It is stated in some works that these wide-mouth fishes shoot insects with a drop of water . . . the action is one which the mouths of these fishes appear incapable of effecting."*

Apparently it never occurred to Day to go out to some Indian river and see the fish shoot. The accomplished Dr. George Bonlenger of the British Museum referred to the "protractile jaws" of the shooting fish, and apparently associated this anatomical feature with the ability of the fish to propel a drop of water; he also mentioned, as the only feeding habit, that the fish knocks down insects flying over the water surface.† Now the jaws of the shooting-fish remain

*Fauna of British India. Fishes. vol. i i. P. 22.
†Cambridge Natural History. Fishes. P. 658.

perfectly rigid when a drop of water is being projected; and insects on the wing are practically never taken.

I am not aware of any published observation or speculation as to the manner in which the fish is able to shoot; and I may therefore refer to a demonstration I made in Bangkok two years ago. A medium-sized fish, caught with a small hook, was held by its back in a basin of water in the position assumed when shooting is imminent and was made to propel a drop of water up to 1 meter, ad libidum, simply by suddenly compressing the gill covers; furthermore the same fish, after having been in formalin for 6 hours, was made to perform in essentially the same way, although the drop of water was not propelled so far. For the performance of this purely mechanical act, all that seem to be required are the long, narrow lower jaw of the true cuspidor artist, the projection of the tip of the lower jaw above the surface, and the sudden forceful compression of the gill-covers.

ANADROMOUS FISHES.

Among the fishes that run from the sea into the streams to spawn, there is a veritable shad, comparing in flavor and size with our own beloved *Alosa sapidissima*. It is found also in Burma and India, where it is known as the hilsa, and in the Malay Archipelago, while in Siam it is called pla talum puk. It is placed in a separate genus *(Hilsa)* owing to slight anatomical characteristics that separate it from the American shad. It is a valued food fish here, and in the large river at Bangkok it supports a special drift-net fishery, with an annual catch of less than 10,000 fish. The fish runs during November to February, and spawns in January and February. Some years ago I took and fertilized a few eggs in the river above Bangkok. The eggs are similar to those of *Alosa* but are very much more numerous and smaller, being only 1 m.m. in diameter after water-hardening.

The shad is now nowhere abundant in Siamese waters, and is a species whose artificial propagation has been suggested. It is in such demand that it is rarely seen in the markets but is bought by consumers directly from the fishing boats while they are still on the fishing grounds.

OTHER FRESH-WATER FISHES.

Among many other kinds of fresh-water fishes that abound in Siam, the following, all of which have features of biologi-

cal or anatomical interest, may be mentioned as often being met with in the markets: Several species of spiny-eels *(Mastacembelus* and *Rhyncobdella)*, one reaching a length of nearly a meter; 2 species of feather-backs *(Notopterus)*, one attaining a length of a meter and rendered conspicuous by its habit of rolling at the surface and exposing its broad, silvery sides; a long, slender, red-bellied eel *(Pisoodonophis)* which breeds in the rice fields; a thread-fin *(Polynemus)*, which among the Siamese is known as pla nuad pram, or Brahmin's-beard fish; several anchovies *(Engraulis, Setipinna, Coilia)*; at least two sole-like fishes *(Synaptura* and *Cynoglossus)*; and many kinds of gobies one of which *(Oxyeleotris)* attains a length of 90 c. m. and is the giant of the goby tribe.

Many other fresh-water fishes might be named, but enough has now been said to give an idea of the richness of the Siamese fish fauna.

TROPICAL AQUARIUM FISH-CULTURE IN INDUSTRY AND SCIENTIFIC RESEARCH

By Myron Gordon.

Hechscher Research Assistant, Cornell University, Ithaca, N. Y.

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Within the past few years there has been a great development in the field of aquarium fish-culture. Goldfish farming has now a firm position among the various commercial enterprises, and, in some communities, as in parts of the State of Maryland, it is one of the leading occupations. More recently its companion industry, tropical aquarium fish farming, has been brought into prominence by the growing popularity of these beautiful, interesting and instructive fishes. The time will soon come when more and more of the present amateur fish fanciers will devote their en-

tire time to a profitable occupation in supplying the increasing demands for these ornamental fishes. At the present time there are many small private greenhouse hatcheries throughout the country and several large well established tropical fish farms.

Aside from the demand created by the general public for tropical fishes, scientific investigators are beginning to utilize these animals in their various fields of research. This should be of greatest significance to those who are now merely interested in the practical side of fish-culture, for the discoveries of the scientist are potentially useful to those in the industry.

These small aquarium fishes promise to be as useful to general fish-culture as the rodents, (the rat, the mouse and the guinea pig) among the mammals, have been in the field of animal husbandry. The great advances made in the better handling and feeding of the larger farm animals have come in a large measure from the discoveries made with the smaller experimental animals.

Tropical viviparous aquarium fishes by virtue of their small size, comparatively rapid rate of reproduction and ease of management (no eggs to fertilize or to hatch artificially) lend themselves excellently to the various experimental tests now being applied to other animals. These fishes have already shown themselves to be valuable material for work in experimental zoology. Most notable has been the progress in the field of genetics where a study of certain forms has contributed some important concepts to the science of heredity.[1] Much is to be expected from experiments attempting species, genus and family crosses, possibilities for which are varied and promising. Some of these crosses have already been accomplished and have yielded interesting results.

Some general information concerning the culture of tropical viviparous top-minnows (killifishes) has already been presented in connection with the report on the Genetics Platypoecilus maculatus, a Mexican species, Gordon 1926. Since limitation of space prevented the inclusion, in the paper just mentioned, of a detailed account of the cultural methods used, the following is presented in the belief that there are some who might be interested in this phase of the work. While these fishes may readily be obtained

[1]For review see Gordon, 1926.

from dealers, the initial cost is rather high; however, stocks may be built up rapidly. The methods here to be discussed have general application to aquarium management of tropical viviparous species.

TEMPERATURE REQUIREMENTS.

Probably the most important cultural detail is that of providing the tropical fishes with a temperature approaching that to which they have been accustomed in their native habitat. Platypoecilus, a typical tropical viviparous species, is found in the most southerly portion of Mexico. It cannot survive northern winters without artificial heat; neither can our native viviparous species, Gambusia, Heterandria and Mollienisia of the South. A constant winter temperature of 24 degrees C. has been found by commercial fanciers to give the best results. At this temperature, maturation is hastened and seasonal reproductive habits destroyed, the young being produced every month in the year. It has been pointed out previously[1] that in the wild habitat the fish spawns at the close of the dry season, which in the region where Platypoecilus occurs extends from April to May.

During the early period of experimentation a constant high temperature was maintained by the use of an eight foot glass show-case, electrically heated and controlled. This served both as an incubator and greenhouse; later, an entire sky-lit room was used.

Reported cases of death due to low temperatures have indicated that 10 degrees C. is very close to the minimum thermal limit. Personal experience, entirely involuntary, has conclusively shown that 40 degrees C. is the maximum thermal point: One evening when the temperature in the glass case rose from 24 degrees C. at 11 p. m. and reached 41 degrees C. at 8 a. m. the next morning, forty fishes, four months old, averaging 12 mm. in length and contained in four battery jars were killed. The points of the thermoregulator had accidently burned and fused. Further away from the source of heat the jars had a temperature of 35 degrees C., and while the animals were distressed no further losses were experienced. (Davenport, 1908, gives 40 degrees C. as the limit for fishes).

[1]Data from Meek, 1904, (Gordon, 1926).

CONTAINERS.

It has been found useful to have two types of containers. Tanks of metal, sides and bottom of glass, 12 inches long by 12 inches wide and 10 inches high are used in rearing young animals, from the age of two months to adults. Glass battery jars 6 inches in diameter and 8 inches high are used for matings and segregation of pregnant females. Fine clean sand, such as is used for water filtration, to the depth of one-half inch is introduced as a bottom cover. This allows the planting of rooted water weeds which are quite essential and without which the water of the aquarium would soon become foul.

PLANTS.

The need of plant life, as a balancing agent in the aquarium, has been emphasized in every paper and book written on the subject. A well illustrated account may be found in Innes, 1921. The plants furnish oxygen to and take up carbon dioxide and waste organic materials from the water. In a well planted aquarium, when the light is strong, oxygen is liberated and comes to the surface in a constant stream of bubbles. More often, however, in aquaria crowded with fishes, the water never reaches the point of oxygen saturation but the purity of the water is nevertheless maintained. The aim has never been to establish a balanced aquarium, but rather to have the balance decidedly in favor of the plants.

In general three species have served exceptionally well in aquaria: Vallisneria spirilis (Italian variety), Elodea canadensis and Riccia fluitans. The first, one of the eel grasses, by virtue of its great root system, which penetrates deeply into the bottom sand, utilizes some of the decaying materials formed by the feces and uneaten food. It is also highly desirable on account of its oxygen producing qualities.

Elodea, or ditch weed, a common native aquatic, is also an excellent oxygenator, having the additional advantage of rapid and prodigious growth. In a jar 6 inches by 8 inches a piece has grown to measure five feet in length, giving off numerous side branches. It may easily be propagated by merely breaking a small portion from the main stem.

Riccia, or crystal-wort, is particularly useful in jars containing pregnant females. When the young are born they have means for escape in among its dense mesh-like branches from their cannibalistically inclined parents. Riccia is also an oxygenator; in addition, it traps the rising bubbles of gas coming from Vallisnaria and Elodea which grow at a lower level, and thus maintains oxygen saturation over a longer period of time.

Under favorable conditions of temperature and light, all of the plants continue to grow luxuriantly through the winter months.

LIGHT.

Plants cannot do their useful work in the aquarium without the influence of light. It is therefore necessary to have a sky-light laboratory or some other arrangement to get the desired effect.

Too much light, especially direct sunlight, together with an abundance of available organic plant food induces algae to make undesirable growth. This may be avoided, sometimes, by shading; but forms like Phacus and Ankistrodesmis are indeed difficult to control. Algae are not wanted because the free-living, unicellular forms, just mentioned, turn the water greenish, obstructing the view, while the filamentous types form tangled, impenetrable masses; they compete too strenuously for light and space with the more desirable species. Some fish culturists go to the no great expense of dropping a penny into each tank; the copper salts formed, though small in quantity, are said to keep the algae in check, and have no effect upon the animals.

WATER.

Water from a swiftly flowing unpolluted creek is preferable for use in the aquarium. Pond water may also be used but care must be observed that the water be free of predaceous forms including disease organisms which might be introduced from native fishes. Tap-water in some respects is better than pond water, since it is most likely to be free of injurious forms. It cannot be used immediately, however, due to the fact that often it is chemically treated with chlorine and alum. By allowing it to remain in a well planted aquarium, the process of self purification will

make it fit for use within a week or two. Usually some volunteer fishes are placed in the tempering tank to test the water.

The growing plants keep the water clean and sufficiently oxygenated so that changes of water are not necessary. However, the detritus accumulates more rapidly than the plants are able to utilize it, forming a fluffy black mass at the bottom. This sediment is siphoned, by means of a rubber hose, into a retaining jar where it is allowed to settle. The clear water above is run off and poured back into the aquarium. "Use old water" is the recommendation given by experienced aquarists. Some fresh water is useful in stimulating the fishes occasionally and of course the loss due to evaporation must always be made up. Tanks and jars are usually filled four-fifths full and are covered with glass to prevent the inmates from leaping out. The matter of glass covers is important for fishes introduced to new locations are prone to escape at first.

BREEDING TECHNIQUE.[1]

Viviparity in Platypoecilus presents some difficulties which must be thoroughly appreciated and overcome before successful and accurate work can be carried on. In rearing a school of young for future mating, constant observation is made to detect and isolate those fish which show beginnings of change in the anal fin. Slight thickening of the fore-margin of the anal fin is indicative of rapid modification of that fin into the male intromittent organ. It is by means of this fin that internal fertilization is effected. (The mode of mating in viviparous species of top-minnows has been described by Winge, 1922, and Bellamy, 1924). Obviously, differentiating males are not allowed to remain with females because of the likelihood of promiscuous mating. Furthermore, as has been pointed out by Gerschler, 1914, females once mated, hold sufficient spermatozoa in the folds of their oviducts to serve for the production of many schools of fishes. He records as many as seven schools having been so produced, each at approximately one month's interval. Winge, 1922, reporting on Lebistes, a viviparous fish of the sub-family Poeciliinae (as is Platypoecilus) says, "Some spermatozoa remain in the oviduct

[1]Quoted from Gordon, 1926; special emphasis is given to methods for genetical work.

where they are able to keep alive for several months, and when the female, a month after fertilization has cast her young, these spermatozoa can fertilize the eggs which have matured in the meantime." It has been found advisable, therefore, to use unmated females for all crosses.

One to several females are crossed with a single male. These are placed in a well planted battery jar. Signs of pregnancy are evidenced by a swelling and distension of the belly of the female. At this time each female is given a separate jar thick planted with Sagittaria, Elodea and, most important, Riccia. The mesh-like branches of the last offer the newly born fishes an excellent hiding place during their first few hours of utter helplessness. To further prevent cannibalism, which must be carefully guarded against, the parent is given an abundance of food. It is at this particular time that live food becomes almost indispensable since quantities may be fed without much danger of polluting the water of the aquarium. It further aids in attracting the attention of the parent away from the young fishes.

When the young are expelled from their mother's body, they straighten out from their previously coiled position and attempt to swim upwards, seeking shelter in the thick vegetation. Within an hour or two their slightly extended yolk sac is entirely absorbed. Most of the members of the newly born school will emerge during the early morning hours, but the entire complement will not usually be expelled until evening. The female is allowed to remain with her young until that time and then removed leaving the progeny in the aquarium. Here they remain for a month or two and then if larger containers are available they are given more room.

FEEDING.

Even before the young are born, food for the coming school is made available to them. It has been observed that within several hours these newly born fishes will attack large protozoans, especially Paramecium caudatum. Cultures of Paramecium are therefore established and introduced into the jars containing the isolated females, a few days in advance of the expected coming of the young.

There have been various methods described for the production of Paramecium in large quantities by the use of

hay infusions, malted milk, cereals, etc., but the following has been found to give satisfactory and constantly good results. A battery jar is filled with old, standing water, preferably a little from several of the experimental aquaria or some stagnant pond. Such water is almost certain to contain the desired ciliate. To this water nothing more is added than a handful of crushed fresh lettuce leaves. (Dried leaves have also been used but the former give results more quickly).

While the history of the changes which take place in the lettuce leaf culture media has not been gone into in any great detail, the following sequence has been observed. If the containers are kept at about 24 degrees C., on the second or third day, the liquid beneath the upper layers of turgid leaves becomes cloudy. Upon the surface of the water a thick whitish gray scum is formed, a microscopic examination of which at this time discloses many diversified types of bacteria in enormous numbers. At the end of a couple of days the bacteria yield to minute protozoans, the former never disappearing however. On one occasion Vorticella practically dominated the situation, although innumerable other forms were found. Usually on the fifth or sixth day Paramecium caudatum will come to the fore and remain the dominating organism.

A small cupful of the upper layers of the culture is taken and poured into the jars containing the young fishes. After two-thirds of the culture is used, the jar is again filled with old water and allowed to stand undisturbed for several days and the ciliates will occur in their former abundance. By having a series of such jars going, a continuous supply is easily maintained. From time to time fresh lettuce leaves are introduced to keep up the bacterial flora, which is apparently the chief food of the protozoans.

It would seem that a cupful of Paramecia and, incidentally, with it the decaying fragments of plant material would be sufficient to pollute the limited contents of the aquarium, but if the latter is well planted, self-purification is remarkably fast. In 24 hours or less, another cupful of culture is introduced, the young fishes readily taking all given to them.

In addition to Paramecia, the small fishes receive pulverized, commercially prepared, fish foods. Shrimp has proven to be the best dried food and the same has been the experience of most of the dealers. For variety, packers

ground meat-meal, fish-meal and dried Daphnia are used. The yolk of hard boiled eggs prepared into a thin paste has been used successfully.

Recently technique has been worked out for the cultivation of certain entomostracans. The use of the lettuce leaf culture media three or four days old, just before Paramecia become dominant, has proven an ideal food for Daphnia magna and Simocephalus vetulus. The former are very large, attaining a length of almost 5 mm., so that it is impossible for the young fish to eat them; however, the daphnids being parthenogenetic, produce young which are readily taken by the fish. The larger daphnids in turn find food for themselves in the decomposing organic matter in the aquarium. In this manner a sort of a self-feeder is established.

As the fishes become three or four months old, coarser dried foods are given and the Paramecium diet is dispensed with. At this age they are also given fresh beef-liver lightly scraped to break up the tough, indigestible, blood vessels and other fibrous tissues. Fish occasionally have been observed to choke to death on meat poorly prepared. Livers of birds are excellent as they do not contain the tough, indigestible, fibrous materials. Fatty tissue is avoided and while vegetable diets such as cooked oatmeal, farina, etc., have been tried they are not eagerly accepted. The yolk of hard boiled eggs is readily eaten and is best served by squeezing it thru the meshes of loosely woven cloth, making it shredded and thereby more easily taken.

At this stage, too, the small white earth-worm, Enchytraeus albidus is fed. This is an ideal food for adult and half-grown fishes, for the oligocheate never grows much over 20 mm. long and 1 mm. thick, and a half-dozen worms are sufficient for one fish per day. Given the proper temperature of about 15 degrees C. they can be raised in large numbers with little trouble, but at temperatures much over 22 degrees C., cultures have never been successful. Many commercial fish fanciers offer them for sale so that stocks are always available.

The following cultural procedure has proved satisfactory: Small wooden boxes 9 by 12 by 5 inches deep, are filled with rich, black earth, such as is found in trunks of dead trees. The black humus of disintegrated leaves is excellent while heavy, non-porous earth is worthless. It has been found advisable to remove as many of the native

inhabitants of leaf mold as possible before introducing the stock of Enchytraeids.

Bread and whatever the worms can find in the natural earth, constitutes their entire diet, the former being supplied as demanded, the point being to keep them constantly well fed. In cooler weather the bread may be soaked in milk but if the temperature goes beyond 18 degrees C. water-soaked bread is preferable as it is less likely to spoil. It is placed immediately beneath the surface and then covered lightly with earth. The whole container is kept moist but not wet. Humid conditions are maintained by placing a piece of moist blotting paper or paper towelling directly upon the surface of the earth and covering this in turn with a light board or pane of glass. Little difficulty is encountered in separating the worms from the soil when they occur, as usually is the case, in clumps one-half to three-quarters of an inch in diameter. Since these worms may remain alive in the aquarium for from twenty-four to forty-eight hours, they are used quite freely in feeding female fishes about to bear their young.

It is of some interest to note that this species although reported to be a common inhabitant of the seashore, ("near high-water mark, under decaying seaweed and stones and inland near the shore", Pratt, 1916) is now, under domestication as it were, perfectly at home far from the sea. It thrives in situations ideally suited to its closely related species, Enchytreaus socialis, which is found "in rotten stumps and logs".

The cultivation of Daphnia and Enchytraeus should be carried on intensively particularly during the winter months for it is at this time that they are especially needed. In late spring, summer and early fall, live food organisms may be collected in the field but care must always be observed not to introduce any predaceous insects into the aquaria. Temporary pools usually harbor various species of entomostraca. Wherever there are creeks flowing over rocky ledges, the larvae of the black fly, Simulium, may usually be found in great numbers. These make excellent food and although at first the fish may refuse them, possibly because of their uninviting black color, they soon learn, after their first nibble, that they are good.

Mosquito larvae have also been fed with success. In fact many fanciers set out tubs baited with odoriferous organic materials to attract the females to deposit their

eggs within. After the eggs have hatched, the larvae are allowed to grow to a size suited to the variously sized fishes. Milk waste as a bait for mosquitoes and a food for their wrigglers has given good results. The midge, Chironomus, often is also attracted and their larvae, bloodworms, are excellent food.

Feeding fishes, not only in aquaria but also in the large fish hatcheries, has been considered an art. An attempt to place the feeding of the latter group (especially trout) on a scientific basis was made by Embody and Gordon, 1924. The best rule to follow in feeding aquarium fishes is to use a wide variety of foods preferably fresh meats or live micro-organisms or both, never feeding more of the non-living food than they can clean up within ten minutes. Overfeeding is particularly injurious, not so much to their digestive systems as, to their respiratory processes because the uneaten food rapidly decomposes and decreases the available oxygen content.

APPENDIX

American Fisheries Society

Organized 1870

Certificate of Incorporation

We, the undersigned, persons of full age and citizenship of the United States, and a majority being citizens of the District of Columbia, pursuant to and in conformity with sections 599 to 603, inclusive, of the Code of Law for the District of Columbia, enacted March 3, 1901, as amended by the acts approved January 31 and June 30, 1902, hereby associate ourselves together as a society or body corporate and certify in writing:

1. That the name of the Society is the American Fisheries Society.

2. That the term for which it is organized is nine hundred and ninety-nine years.

3. That its particular business and objects are to promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; to unite and encourage all interests of fish culture and the fisheries; and to treat all questions of a scientific and economic character regarding fish; with power:

(a) To acquire, hold and convey real estate and other property, and to establish general and special funds.

(b) To hold meetings.

(c) To publish and distribute documents.

(d) To conduct lectures.

(e) To conduct, endow, or assist investigation in any department of fishery and fish-culture science.

(f) To acquire and maintain a library.

(g) And, in general, to transact any business pertinent to a learned society.

4. That the affairs, funds and property of the corporation shall be in general charge of a council, consisting of the officers and the executive committee, the number of whose members for the first year shall be seventeen, all of whom shall be chosen from among the members of the Society.

Witness our hands and seals this 16th day of December, 1910.

Seymour Bower	(Seal)
Theodore Gill	(Seal)
William E. Meehan	(Seal)
Theodore S. Palmer	(Seal)
Bertrand H. Roberts	(Seal)
Hugh M. Smith	(Seal)
Richard Sylvester	(Seal)

Recorded April 16, 1911.

CONSTITUTION AND BY-LAWS.

(As amended to date)

ARTICLE I

NAME AND OBJECT

The name of this Society shall be American Fisheries Society. Its object shall be to promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; the uniting and encouraging of all interests of fish culture and the fisheries, and the treatment of all questions regarding fish, of a scientific and economic character.

ARTICLE II

MEMBERSHIP

Active Members.—Any person may upon a two-thirds vote of the members present at any regular annual meeting and upon the payment of one year's dues become an active member of this Society.

The annual dues of active members shall be three ($3.00) dollars per year, payable in advance. In case of non-payment of dues for two consecutive years, notice shall be given by the Treasurer in writing, and such member remaining delinquent after one month from the date of such notice, his name shall be dropped from the roll of the Society. Such delinquent member, having been dropped for non-payment of dues shall be ineligible for election as a new member for a period of two years, except upon payment of arrears.

Club Members.—Any sporting or fishing club or society, or any firm or corporation, upon a two-thirds vote of the members present at any regular annual meeting and upon the payment of one year's dues, may become a club member of this Society. The annual dues of club members shall be five ($5.00) dollars per year.

Libraries.—Libraries shall be admitted to membership upon application and the payment of one year's dues. The annual dues for libraries shall be three ($3.00) per year.

State Memberships.—Any State, Provincial of Federal Department of the United States, Canada or Mexico may, upon application and the pay-

ment of one year's dues become a state member of this Society. The Annual dues for State Memberships shall be ten ($10.00) dollars per year.

Life Memberships.—Any person may, upon a two-thirds vote of the members present at any regular annual meeting and the payment of fifty ($50.00) dollars become a life member of this Society and shall thereafter be exempt from payment of annual dues. The President, Secretary and Treasurer of the Society are hereby authorized to transfer members from the active list to the list of life members at their discretion for good and sufficient reason, such as inability to pay dues, provided that no member shall be so transferred unless he shall have paid dues as an active member of the Society for at least twenty-five years.

Patrons.—Any person, society, club, firm or corporation, on approval of the Executive Committee and the payment of fifty ($50.00) dollars or more, may become a patron of this Society with all the privileges of a life member, and shall be listed in all the published membership lists of the Society.

Honorary and Corresponding Members.—Any person may be made an honorary or corresponding member upon a two-thirds vote of the members present at any regular annual meeting of the Society. The President (by name) of the United States, the Governors (by name) of the several states and the Secretary of Commerce of the United States (by name) shall be honorary members of the Society.

Election of Members Between Annual Meetings.—The President, Secretary and Treasurer of the Society are hereby authorized during the time intervening between annual meetings, to receive and act upon all applications for individual and club memberships. A majority of such committee shall decide upon the acceptance of such applications.

Voting.—Active members and life members only shall have the right to vote at regular or special meetings of the Society. Fifteen voting members shall constitute a quorum for the transaction of business.

ARTICLE III

Funds

Current Fund.—All moneys received from the payment of dues of active members, club members, libraries, life members, state members, sale of Transactions, contributions thereto, and from any miscellaneous sources, shall be credited to the Current Fund of the Society and shall be paid out only on vouchers regularly approved by the President and Secretary.

Permanent Fund.—The President, Secretary and Treasurer shall be the Trustees of the Permanent Fund. All moneys received from patrons, bequests and contributions thereto shall be credited to the Permanent Fund of the Society. Such fund shall be invested by the Treasurer in such manner as may be approved by the trustees of such fund. The members of the Society shall, at each annual meeting, determine the disposition of interest accruing from such investment.

ARTICLE IV

Officers

The officers of this Society shall be a President and a Vice-president, who shall be ineligible for election to the same office until a year after the expiration of their term; a Secretary, a Treasurer, a Librarian, and an Executive Committee of seven, which, with the officers before named, shall form a council and transact such business as may be necessary when the Society is not in session—four to constitute a quorum.

In addition to the officers above named there shall be elected annually five Vice-presidents who shall be in charge of the following five divisions or sections:

1. Fish Culture.
2. Commercial Fishing.
3. Aquatic Biology and Physics.
4. Angling.
5. Protection and Legislation.

No officer of this Society shall receive any salary or compensation for his services and no allowances shall be made for clerical services except by vote of the Society at regular annual meetings.

Duties of Officers.—The President shall preside at the annual and all special meetings of the Society, shall be ex-officio chairman of the Council of the Society, and shall exercise general supervision over the affairs of the Society.

The Vice-President shall act in the place of the President in case of absence or inability of the latter to serve.

The Secretary shall keep the records of the Society, attend to the publication and distribution of its Transactions, attend to its correspondence, promote its membership, and arrange for annual and special meetings.

The Treasurer shall receive and collect all dues and other income of the Society, shall have the custody of its funds and pay all claims which have been duly approved. The Treasurer shall furnish a bond in the sum of one thousand ($1,000.00) dollars to be approved by the Executive Committee and to be paid for by the Society.

The Librarian shall have the custody of the library of the Society, in-

cluding its permanent records and printed Transactions and shall have charge of the sale of surplus copies of such Transactions. Other officers shall perform such duties as shall be assigned them by the President.

ARTICLE V

Meetings

The regular meeting of the Society shall be held once a year, the time and place being decided upon at the previous meeting, or, in default of such action, by the Executive Committee.

ARTICLE VI

Order of Business

1. Call to order by the President.
2. Roll call of members.
3. Applications for memberships.
4. Reports of officers.
   a. President.
   b. Secretary.
   c. Treasurer.
   d. Vice-Presidents of Divisions.
   e. Standing Committees.
5. Committees appointed by the President.
   a. Committee of five on nomination of officers for ensuing year.
   b. Committee of three on time and place of next meeting.
   c. Auditing committee of three.
   d. Committee of three on program.
   e. Committee of three on publication.
   f. Committee of three on publicity.
6. Reading of papers and discussions of same.
   (*Note*—In the reading of papers preference shall be given to the members present).
7. Miscellaneous business.
8. Adjournment.

ARTICLE VII

Changing the Constitution

The Constitution of the Society may be amended, altered or repealed by a two-thirds vote of the members present at any regular meeting, provided at least fifteen members are present at said regular meeting.

American Fisheries Society

LIST OF MEMBERS, 1926-1927.

(Showing Year of Election to Membership)

HONORARY MEMBERS

The President of the United States
The Secretary of Commerce of the United States.
The Governors of the several States.
'08 Antipa, Prof. Gregoire, Inspector-General of Fisheries, Bucharest, Roumania.
'06 Besana, Giuseppe, Lombardy Fisheries Society, Via Rugabello 19, Milan, Italy.
'09 Blue Ridge Rod and Gun Club, Harper's Ferry, W. Va.
'93 Borodin, Nicolas Brooklyn Museum, Brooklyn, N. Y.
'12 Calderwood, W. L., Inspector of Salmon Fisheries for Scotland, Edinburgh, Scotland.
'04 Denbigh, Lord, London, England.
'04 Kishinouye, Dr. K., Imperial University, Tokyo, Japan.
'88 Lake St. Clair Shooting and Fishing Club, Detroit, Mich.
'17 Mercier, Honore, Minister of Colonization, Mines and Fisheries, Quebec, Canada.
'09 Nagel, Hon. Chas., St. Louis, Mo.
'95 New York Association for the Protection of Fish and Game, New York City.
'08 Nordqvist, Dr. Oscar Fritjof, Superintendent of Fisheries, Lund, Sweden.
'06 Perrier, Prof. Edmond, Director Museum of Natural History, Paris, France.
'92 Vinciguerra, Prof. Dr. Decio, Director Royal Fish Culture Station, Rome, Italy.

CORRESPONDING MEMBERS

'84 Apostolides, Prof. Nicoly Chr., Athens, Greece.
'87 Armistead, J. J., Dumfries, Scotland.
'04 Ayson, L. F., Commissioner of Fisheries, Wellington, New Zealand.
'22 Director, All-Russian Agricultural Museum, Fontanka 10, Petrograd, Russia.
'22 Director of Fisheries (British Malay), Singapore, Straits Settlements.
'08 Higginson, Eduardo, Consul for Peru, New York City.
'84 Landmark, A., Inspector of Norwegian Fresh Water Fisheries, Christiania, Norway.

'22 Library, National Museum of Natural History, Paris, France.
'84 Marston, R. B., Editor of the Fishing Gazette, London, England.
'08 Potteau, Charnley, Lommel, Belgium.
'84 Sars, Prof. G. O., Christiania, Norway.
'10 Stead, David G., Fisheries Department, Sydney, New South Wales, Australia.

PATRONS

'14 Alaska Packers Association, San Francisco, Calif.
'15 Allen, Henry F., (Agent, Crown Mills), 210 California St., San Francisco, Calif.
'15 American Biscuit Co., 815 Battery St., San Francisco, Calif.
'15 American Can Co., Mills Building, San Francisco, Calif.
'15 Armour & Co., Battery and Union Sts., San Francisco, Calif.
'15 Armsby, J. K., Company, San Francisco, Calif.
'15 Atlas Gas Engine Co., Inc., Foot of 22nd Avenue, Oakland, Calif.
'15 Balfour, Guthrie & Co., 350 California St., San Francisco, Calif.
'15 Bank of California, N. A., California and Sansome Sts., San Francisco, Calif.
'15 Bloedel-Donovan Lumber Mills, Bellingham, Wash.
'15 Bond and Goodwin, 485 California St., San Francisco, Calif.
'15 Burpee and Letson, Ltd., South Bellingham, Wash.
'15 California Barrel Co., 22d and Illinois Sts., San Francisco, Calif.
'15 California Door Co., 43 Main St., San Francisco, Calif.
'15 California Stevedore and Ballast Co., Inc., 210 California St., San Francisco, Calif.
'15 California Wire Cloth Company, San Francisco, Calif.
'15 Caswell, Geo. W., Co., Inc., 503-4 Folsom St., San Francisco, Calif.
'15 Clinch, C. G., & Co., Inc., 144 Davis St., San Francisco, Calif.
'15 Coffin-Redington Co., 35-45 Second St., San Francisco, Calif.
'15 Columbia River Packers Association, Astoria, Ore.
'15 Crane Co. (C. W. Weld, Mgr.) 301 Brennan St., San Francisco, Calif.
'15 Dodge, Sweeney & Co., 36-48 Spear St., San Francisco, Calif.
'15 First National Bank of Bellingham, Bellingham, Wash.
'15 Fuller, W. P., & Co., 301 Mission St., San Francisco, Calif.
'15 Grays Harbor Commercial Co., Foot of 3d St., San Francisco, Calif.
'15 Hendry, C. J., Co., 46 Clay St., San Francisco, Calif.
'15 Jones-Thierbach Co., The, Battery and Merchant Sts., San Francisco, Calif.
'15 Knapp, The Fred H., Co., Arcade-Maryland Casualty Building, Baltimore, Md.
'15 Linen Thread Co., The, (W. A. Barbour, Mgr.), 443 Mission St., San Francisco, Calif.
'15 Mattlage, Chas. F., Company, 335 Greenwich St,. New York City.

'15 Nauman, C., & Co., 501-3 Sansome St., San Francisco, Calif.
'15 Oliver Salt Co., Mt. Eden, Calif.
'15 Morrison Mill Co., Inc., Bellingham, Wash.
'15 Morse Hardware Co., Inc., 1025 Elk St., Bellingham, Wash.
'15 Pacific Hardware and Steel Co., 7th and Townsend Sts., San Francisco, Calif.
'15 Pacific States Electric Co., 575 Mission St., San Francisco, Calif.
'15 Phillips Sheet and Tin Plate Co., Weirton, W. Va.
'15 Pope and Talbot, Foot of 3d St., San Francisco, Calif.
'15 Puget Sound Navigation Co., Seattle, Wash.
'15 Ray, W. S., Mfg. Co., Inc., 216 Market St., San Francisco, Calif.
'15 Schmidt Lithograph Co., 2d and Bryant Sts., San Francisco, Calif.
'15 Schwabacher-Frey Stationery Co., 609-11 Market St., San Francisco, Calif.
'15 Ship Owners' and Merchants' Tug Boat Co., Foot of Green St., San Francisco, Calif.
'15 Sherwin-Williams Co., The, 454 Second St., San Francisco, Calif.
'15 Smith Cannery Machine Co., 2423 South First Avenue, Seattle, Wash.
'15 Standard Gas Engine Co., Dennison and King Sts., Oakland, Calif.
'15 Standard Oil Co. of California, Standard Oil Building, San Francisco, Calif.
'15 U. S. Rubber Co. of California (W. D. Rigdon, Mgr.) 50-60 Fremont St., San Francisco, Calif.
'15 U. S. Steel Products Co., Rialto Building, San Francisco, Calif.
'15 Wells Fargo National Bank of San Francisco, Montgomery and Market Sts., San Francisco, Calif.
'15 Western Fuel Co., 430 California St., San Francisco, Calif.
'15 Western Meat Co., 6th and Townsend Sts., San Francisco, Calif.
'15 White Bros., 5th and Brannan Sts., San Francisco, Calif.

ACTIVE MEMBERS

'23 Acklen, Col. Joseph H. Nashville, Tenn.
'16 Adams, Prof. Charles C. State Museum, Univ. of the State of N. Y., Albany, N. Y.
'13 Adams, William C. Division of Fisheries & Game, State House, Boston, Mass.
'18, '23 Ainsworth, Seth M. Supt., Bureau of Fisheries, Saratoga, Wyoming.
'20 Albert, W. E. State Fish & Game Warden, Des Moines, Iowa.
'98 Alexander, George L. Grayling, Mich.
'25 Allsopp, Edward E. 33 East Kinney St., Newark, N. J.
'26 Alm, Dr. Gunnar Commissioner of Freshwater Fisheries, Lantbruksstyrelsen, Stockholm, Sweden.
'23 Amsler, Guy Department of Fish & Game, Little Rock, Ark.
'24 Anderson, Anders Shoshone Falls, Jerome, Idaho.
'08 Anderson, August J. Box 704, Marquette, Mich.
'14 Anderson, T. T. 4241 Folsom Avenue, St. Louis, Mo.
'24 Annin, Harry K. Spring Street, Caledonia, N. Y.

'14 Annin, Howard Caledonia, N. Y.
'78 Annin, James Caledonia, N. Y.
'10 Augur, W. A. 33 Fulton Street, New York City, N. Y.
'25 Atherton, Giles El Dorado, Kansas.
'06 Avery, Carlos 2273 Woolworth Bldg., New York City, N. Y.
'01 Babcock, John P. Provincial Fisheries Department, Victoria, B. C., Canada.
'12 Babcock, William H. 140 South Dearborn St., Chicago, Ill.
'18 Bailey, Arthur T. R. F. D. 1, Nashua, N. H.
'25 Bailliere, F. Lawrence 220 W. 19th St., Tulsa, Okla.
'23 Baird, John Director, Department of Conservation, Lansing, Mich.
'25 Baker, Augustus L. L. Dover, N. J.
'15 Balch, Howard K. 158 West Austin Ave., Chicago, Ill.
'01 Baldwin, O. N. U. S. Bureau of Fisheries, Saratoga, Wyo.
'98 Ball, E. M. U. S. Bureau of Fisheries, Washington, D. C.
'23 Bangham, Ralph V. Wooster College, Wooster, Ohio
'20 Barbour, F. K. 96 Franklin St., New York City, N. Y.
'05 Barbour, Prof. Thomas Museum of Comparative Zoology, Cambridge, Mass.
'26 Barnes, J. Sanford 52 Vanderbilt Ave., New York, N. Y.
'17, '24 Barney, Raymond L. Middlebury College, Middlebury, Vt.
'19-'25 Bartlett, Mott L. Commissiioner of Fisheries & Game, Concord, N. H.
'23 Baskett, Cecil M. P. O. Box 1165, St. Louis, Mo.
'12 Bauer, A. 2500 South Dearborn St., Chicago, Ill.
'22 Bayne, Bliss Game & Fish Department, Capitol Bldg., Cheyenne, Wyoming.
'24 Beakbane, Lionel R. F. D. 2, Gansevoort, N. Y.
'23 Beard, Harry R. U. S. Fisheries Laboratory, San Pedro, Cal.
'00 Beeman, Henry W. New Preston, Conn.
'18 Bellisle, J. A. Inspector General of Fisheries & Game, Quebec, Canada.
'80 Belmont, Perry 1618 New Hampshire Ave., Washington, D. C.
'25 Bengard, John P. Valley Ranch, New Mexico.
'13 Berg, George Indiana Fish Commission, Indianapolis, Ind.
'06 Berkhous, Jerry R. Torresdale Fish Hatchery, Holmesburg, Philadelphia, Penn.
'19 Bernard, Gus Bernard Fish Company, Atchafalaya, La.
'23 Berwick, Dudley Eunice, La.
'24 Bitzer, Ralph Montague, Mass.
'24 Blanchard, Charles State Fish Hatchery, Unionville, Conn.
'25 Blankenship, Dr. E. L. Cassville, Mo.
'24 Bobleter, J. W. Supt., Yellowstone Hatchery, Emigrant, Mont.
'25 Bolles, Henry J. U. S. Fisheries Station, Bozeman, Montana.
'23 Bolstad, Sidney L. 4344 N. Winchester Ave., Chicago, Ill.
'14 Bolton, C. C. 1550 Hanna Bldg., Cleveland, Ohio.
'20 Bonner, Albert E. Coopersville, Mich.
'02 Booth, DeWitt C. U. S. Bureau of Fisheries, Spearfish, S. D.
'26 Borcea, Dr. Jean Univ. of Jassy, Jassy, Roumania.
'14 Bordenkecher, William R. R. 19, Haughville Station, Indianapolis, Ind.
'25 Borger, Samuel I. Brookhaven, Long Island, N. Y.
'25 Bottler, P. G. State Fish Hatchery, Emigrant, Montana.
'23 Bourland, Dubart E. U. S. Bureau of Fisheries, Tupelo, Miss.
'00 Bower, Ward T. U. S. Bureau of Fisheries, Washington, D. C.
'20 Breder, C. M. Jr., New York Aquarium, New York City, N. Y.

'16 Brown, Dell U. S. Bureau of Fisheries, Mammoth Springs, Ark.
'14 Brown, Ernest Clive Box 107, Station G., New York City, N. Y.
'04 Brown, G. W. N. U. S. Bureau of Fisheries, Orangeburg, S. C.
'25 Browne, R. S. W. 452 Browne-Marx Bldg., Birmingham, Ala.
'23 Brunson, J. H. Louisville, Nebraska
'10 Bryan, Prof. William Alanson Director, Los Angeles Museum, Exposition Park, Los Angeles, Cal.
'25 Buckmaster, Walter C. Bozeman, Montana.
'18 Buckstaff, George A. 1101-1501 South Main St., Oshkosh, Wis.
'26 Buford, Henry State Fish Hatchery, Eastaboga, Ala.
'25 Bull, H. O. The Laboratory, Citadel Hill, Plymouth, England.
'20 Buller, C. R. Pleasant Mount, Wayne County, Penn.
'12 Buller, G. W. Pleasant Mount, Wayne County, Penn.
'19 Bullock, Charles A. U. S. Bureau of Fisheries, Bullochville, Ga.
'17 Burkhart, Joe Big Rock Creek Trout Club, St. Croix Falls, Wis.
'07 Burnham, Charles W. U. S. Bureau of Fisheries, Louisville, Ky.
'26 Burnham, Gordon W. 52 W. 50th St., New York City, N. Y.
'25 Burnham, John B. 233 Broadway, New York City.
'20 Buschmann, L. C. Deep Sea Salmon Co., 209-12 Lowman Bldg., Seattle, Wash.
'17, '22 Canfield, H. L. U. S. Fisheries Station, Homer, Minn.
'25 Carpenter, M. S. Missoula, Montana.
'16-'25 Casler, Wm. A. U. S. Bureau of Fisheries, Washington, D. C.
'23 Catt, James District Inspector of Hatcheries, R. R. 1., St. John, New Brunswick, Canada.
'07 Catte, Eugene Catte Fish Hatchery, Langdon, Kansas.
'18 Chamberlain, Thomas Knight 428 Forest Ave., Palo Alto, Calif.
'17 Chambers, E. T. D. Department of Colonization, Mines & Fisheries, Quebec, Canada.
'25 Christianson, William State Fish Hatchery, St. Paul, Minnesota.
'18 Christoffers, H. J. U. S. Fisheries Service, 1217 L. C. Smith Bldg., Seattle, Wash.
'26 Chu Yuanting T. St. John's University, Shanghai, China.
'25 Clark, George A. Topeka, Kansas.
'11 Clark, H. Walton Steinhart Aquarium, Golden Gate Park, San Francisco, Cal.
'23 Claybaugh, D. K. Coleman Lake Club, Goodman, Wis.
'21 Clemens, Dr. Wilbert A. Pacific Biological Station, Nanaimo, British Columbia, Canada.
'00 Cobb, Eben W. R. F. D., Farmington, Conn.
'04 Cobb, John N. College of Fisheries, Univ. of Washington, Seattle, Wash.
'04 Coker, Dr. Robert E. Univ. of North Carolina, Chapel Hill, N. C.
'13 Coles, Russell J. Danville, Va.
'25 Colley, Josh State Fish Hatchery, Emigrant, Montana.
'26 Collins, J. L. 15 State St., Boston, Mass.
'19 Commerford, William Milebrook Hatchery, R. F. D. 6, Boonville, N. Y.
'26 Connett, Eugene V. 3rd 170 Turrell Ave., S. Orange, N. J.
'22 Cook, Frank Albany County Hatchery, Box 605, Laramie, Wyo.
'17 Cook, Ward A. U. S. Bureau of Fisheries, Duluth, Minn.
'24 Coolidge, Charles A. 122 Ames Building, Boston, Mass.
'25 Corfman, Frank M. State Fish Hatchery, Harrisville, Mich.
'24 Corson, R. H. 2814 Boulevard., Jersey City, N. J.
'26 Cottrell, Ted Chief Game Warden, Birmingham, Ala.
'18 Coykendall, Edward 22 Ferry St., Kingston, N. Y.
'21 Craig, Samuel 398 Van Norman St., Port Arthur, Ontario, Canada.

'13 Crandall, A. J. Ashaway Line & Twine Co., Ashaway, R. I.
'11 Crasser, Hugo U. S. Bureau of Fisheries, La Crosse, Wis.
'25 Crile, Dr. George 2620 Derbyshire Road, Cleveland, Ohio.
'25 Cruikshank, J. H. 3120 Federal St., El Paso, Texas.
'25 Cuenin, J. P. San Francisco Examiner, San Francisco, Calif.
'08 Culler, C. F. U. S. Bureau of Fisheries, La Crosse, Wis.
'23 Curtis, Brian C. 125 East 57th St., New York City, N. Y.
'25 Cuyler, George A. State Fish Hatchery, Harrisville, Mich.
'12 Danglade, Ernest Vevay, Indiana.
'06 Davies, David U. S. Fisheries Station, Put-in-Bay, Ohio.
'23 Davis, Dr. H. S. U. S. Bureau of Fisheries, Washington, D. C.
'91, '10 Dean, Prof. Bashford Columbia Univ. New York City, N. Y.
'01 Dean, Herbert D. U. S. Bureau of Fisheries, Charlevoix, Mich.
'24 Dence, Wilford A. New York State College of Forestry, Syracuse, N. Y.
'25 Decozen, Alfred 1226 Broad St., Newark, N. J.
'25 Delgado, T. P. Santa Fe, New Mexico.
'19 Denmead, Talbott Bureau of Biological Survey, Dept. of Agri., Washington, D. C.
'23 Dennig, Louis E. 3817 Choteau, St. Louis, Mo.
'08 Detweiler, John Y., Honorary Pres. Florida Fish Commission, New Smyrna, Fla.
'24 Dickinson, William E. Public Museum, Milwaukee, Wis.
'23 Dillon, Horace State Fish Hatchery, Story, Wyo.
'99 Dinsmore, A. H. U. S. Bureau of Fisheries, St. Johnsbury, Vt.
'25 Doellner, Fred H. 267 E. Wabasha Street, Winona, Minnesota.
'09 Doyle, Henry 101 Winch Bldg. Vancouver, B. C., Canada.
'23 Doze, J. B. State Fish Hatchery, Pratt, Kansas.
'20 Dryfoos, Leon 508 State St., Erie, Penn.
'23 Duncan, Charles W. U. S. Bureau of Fisheries, Tupelo, Miss.
'00 Dunlap, Irving H. U. S. Bureau of Fisheries, Washington, D. C.
'24 Earle, Swepson Conservation Commission, Baltimore, Md.
'23 Edmondson, Claude L. Boone Fish Hatchery, Boone, N. C.
'13 Embody, Dr. George C. Triphammer Road, Ithaca, N. Y.
'21 Emerich, Walter G. R. F. D. 1, Watervliet, N. Y.
'23 Engelhardt, Fred U. S. Bureau of Fisheries, Washington, D. C.
'17 Erickson, C. J. P. O. Box 1446, Boston 2, Mass.
'20 Evans, H. R. Cultus Lake Hatchery, Vedder Crossing Post Office, British Columbia, Canada.
'06 Evans, Lieut.-Col. Kelly Metropolitan Club, New York City, N. Y.
'04 Evermann, J. W. Supervisor of Public Utilities, Dallas, Texas.
'25 Evers, Ade President Izaak Walton League, Nashville, Ark.
'24 Fabyon, Francis H. 72 Franklin St., Boston, Mass.
'26 Faulkner, Chris. Frontmere Fish Hatchery, Osceola, Wis.
'25 Faye, James J. P. O. Box 1618, Denver, Colo.
'26 Ferris, John H. Arlington, Vt.
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'21 Club Denarius Barnesboro, Pa. (C. A. Colbert, 310 Bigler Ave.)
'21 Cumberland County Fish & Game Association Portland, Maine. (George C. Orr, Sec.)
'22 Ferndale Rod & Gun Club New Auburn, Wis. (Frank H. Foster, Pres., H. A. Barnhardt, Treas., 139 North Clark St., Chicago Ill.)
'26 Knapp, Theodore, East Islip, L. I., N. Y.
'21 Lowell Fish & Game Association, Lowell, Mass. (F. W. Burrows, Sec., 646 Gorham St.)
'22 Massachusetts Fish & Game Protective Association Boston, Mass. (3 Joy St.)
'26 Mashpee Trout Club, J. W. Farley, Treas., 1 Federal St., Boston, Mass.
'25 Middlesex Co. Hunting & Fishing Club, New Brunswick, (Raymond R. Hoagland, Rec. Secy.) N. J.
'21 Montgomery County Fish, Game & Forestry Association (H. G. Unger, Sec. 820 West Marshall St., Morristown, Penn.)
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'95 N. Y. Association for the Protection of Game, J. C. O'Conor, 15 William St., New York City.
'23 Nickerson, John C. Gilbert Trout Hatchery, P. O. Box 124, Plymouth, Mass.
'21 Paradise Brook Trout Company, Cresco, Penn.
'24 Paulhus, J. A. 18 Bonsecours St., Montreal, Canada.
'21 Pennsylvania State Fish & Game Protective Association. (W. Major Beatty, Treas., 815 Land Title Bldg., Philadelphia, Pa.)
'11 Pohoqualine Fish Association (Evan Randolph, Secy., c/o Philadelphia-Girard Nat'l Bank, P. O. Box 1906, Philadelphia, Penn.)
'21 Porter's Lake Hunting & Fishing Club (Otto C. Feil, Sec., 2207 North 6th St., Philadelphia, Penn.)
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